

2015

Lockport Prairie Ecosystem Restoration

Section 206 Aquatic Ecosystem Restoration

Feasibility Study and Integrated Environmental Assessment
Lockport Township, Will County, Illinois
Forest Preserve District of Will County



Chicago District
US Army Corps of Engineers
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**Lockport Prairie Ecosystem Restoration
Feasibility Study and Integrated Environmental Assessment**

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*Removed for Public Review

EXECUTIVE SUMMARY

This study investigates the water resource problems and opportunities at Lockport Prairie Nature Preserve (LPNP) and the surrounding project area. LPNP is located in Will County, Illinois and the project area includes the Prairie Bluff Preserve (PBP) located along western border of LPNP. This Feasibility Report presents the assessment of ecological conditions and potential plans to restore important native plant habitat that includes two federally listed plant species (Lakeside Daisy and Leafy Prairie Clover), migratory bird and wildlife habitat within and adjacent to critical habitat for the federally listed Hine's Emerald Dragonfly. This report includes historic and current site conditions, forecasts future without and future with project conditions and provides a recommended plan for restoring habitat at LPNP. The local sponsor, The Forest Preserve District of Will County, and other stakeholders are concerned about ecosystem degradation including problems with the quality of native plant communities, environmental degradation and invasive species.

LPNP contains wet and wet-mesic dolomite prairie, a globally rare type of plant community. Less than 45-acres of dolomite prairie have been identified across the globe and 19-acres occur at LPNP. It also supports 3 federally-listed species and numerous other state-listed species. For these reasons it has undergone a number of ecological studies, especially of ground water dynamics, which supports most of the species of concern, especially the Hine's Emerald Dragonfly, a federally-endangered species. The federally listed Lakeside Daisy and Leafy Prairie Clover require high quality prairie communities and LPNP floristic quality has been declining over the years as invasive plant species spread across the site. An investigation by Chicago District of these earlier studies plus 2006 and 2014 field work conducted by the District using the Floristic Quality Assessment (FQA) method indicated that the floristic quality had dropped since 2002, along with a shift toward species that prefer a drier habitat. These findings correlate with a concurrent study performed by the Forest Preserve District of Will County that showed a drop in ground water elevations. Other signs of hydrologic disturbance have also been observed, most notably the death of several of the state-listed spotted turtles due to the drawdown of ground water while they hibernated. Therefore, the project site is good candidate for an aquatic ecosystem restoration project. After an assessment of various studies, the following problems were identified:

- Problem: Ecosystem degradation causing the decline in Hine's Emerald Dragonfly habitat and a decline in floristic quality caused by a drop in the ground water that discharges into LPNP; and,
- Problem: The area of PBP, which is located within the recharge zone of the LPNP aquifer, is impacted by an extensive system of drain tiles that carries precipitation away from the aquifer and the current properties of the soil will not support the deep-rooted native vegetation that encourages infiltration; and,
- Problem: Surface water from the major highway that borders the western edge of LPNP negatively impacts the integrity of the site; and,
- Problem: An area along the bluffs next to the intersection of Division Street is negatively influenced by large quantities of surface water runoff and an eroded denuded gully has formed; and,
- Problem: Invasive species have established in sections of the project area, are disrupting the functionality of the aquatic ecosystem and pose a larger threat of eventually displacing native plant species along with federally listed species (Hine's Emerald Dragonfly, Lakeside Daisy and Leafy Prairie Clover) that depend on high quality native plant species.

The study analyzed seven (7) alternative sets of measures that had the potential for accruing ecological benefits. The restoration average annual (AA) costs ranged from \$19,995 to \$680,393 dollars and ecosystem outputs ranged from 1.15 to 340.47 net average annual habitat units (AAHUs). Based on these inputs and criteria, the IWR-Planning software generated fifty-four (54) alternative combinations for ecosystem restoration. These alternative combinations were analyzed with the IWR Planning Suite Cost Effective & Incremental Cost Analysis.

The cost effectiveness analysis was used to ensure that certain options would be screened out if they produced the same amount or less output at a greater cost than other options with a lesser cost. Fifty-four (54) alternative combinations were analyzed for cost effectiveness. Of these, twenty-six (26) cost effective combinations were identified, which is inclusive of the five (5) Best Buy Plans. The No Action plan is always deemed cost effective and a Best Buy Plan.

An incremental cost analysis was performed on the five (5) Best Buy Plans, including no action, identified from the cost effectiveness analysis:

Alternative Plan 1: No Action

This plan would not meet or address any of the current problem areas or opportunities and is not supported by the FPDWC (local sponsor).

Alternative Plan 2: This plan includes the restoration of the hydrology of PBP (MU1, see figure 7) through drain tile disablement, mowing of weedy herbaceous plant species, prescribed burns and native seed installation into the newly created marsh, wet prairie, wet mesic prairie and mesic prairie of PBP. This plan addresses a few of the objectives, such as an increased rate of water retained and available to infiltrate to the groundwater table that will eventually discharge into LPNP, addresses quality and acreage of high quality plant communities through the disablement of agricultural fields into four native plant communities and increases the amount of nesting habitat for grassland bird species. However, it only partially addresses restoration and sustainability of the habitat for federally listed species as it does not address issues within the management units of LPNP (MU2 – 4) such as invasive herbaceous and woody species. Also, this plan would not address the erosion problem within the oak savanna in MU2. This plan would result in a net gain of 271.42 AAHU for an AA cost of \$390,702.

Alternative Plan 3: This plan includes the restoration measures in Alternative Plan 2, also addresses problems within PBP (MU1) (e.g., drain tile disablement) and addresses invasive herbaceous and woody species within MU3 of LPNP. This alternative would partially address problems within areas delineated as critical habitat for the federally listed species in MU3, but not within MU4. Another gap in this plan is that it would not address the erosion problem or invasive species problem within MU2. This plan would result in a net gain of 303.09 AAHU for an AA cost of \$519,768.

Alternative Plan 4: This plan includes restoration measures within Alternative Plans 2 and 3 and it would address invasive herbaceous and woody species and erosion within the oak savanna and marsh communities within MU2 of LPNP. The one remaining objective, but critically important, not covered includes the habitat of federally listed species within MU4 of LPNP. This plan would only partially address problems associated with presence of invasive species, quality and acreage of native plant communities and the restoration of habitat for federally listed species. This plan would result in a net gain of 309.64 AAHU for an AA cost of \$547,072.

Alternative Plan 5: This plan includes the restoration measures in Alternative Plan 2, Alternative Plan 3 and Alternative Plan 4, in addition, the native plant restoration would vastly improve the quality of the habitat for native wildlife species. The removal of invasive species within LPNP (MU2, MU3 and MU4) would improve the quality of the rare plant communities and protect the habitat of federally listed species (Hine's Emerald Dragonfly, Lakeside Daisy and Leafy Prairie Clover) from being overgrown with invasive species. The removal of selected woody species and replacing them with the appropriate native species along the poor quality slope areas (MU2) would greatly enhance not only the floristic quality in the area, but would also help improve the area erosion as a result of surface water runoff from Route 53. Surface water runoff would also be improved by removing invasive shrubs and planting native herbaceous species, which will slow down the water and allow sediments to fall out, coupled with the filtering of pollutants by native plant species, would result in less sediment entering LPNP. This plan meets the goals and objectives of the study and meets all four of the Principles and Guidelines criteria. This plan is fully supported by the non-Federal sponsor. Specific elements of Alternative 5 are:

Specific elements of Alternative 5 are:

- Full hydrologic restoration
 - Drainage tile disablement
 - Erosion control
- Full invasive species removal
 - Selective clearing of woody species
 - Herbicide application of woody and herbaceous species
 - Prescribed burning
 - Selective mowing
- Full native plant restoration
 - Hand sow and plant appropriate plant community mixes to increase habitat diversity and in areas of invasive removal to discourage the reestablishment of said species

The plan that reasonably maximizes net National Ecosystem Restoration benefits and is consistent with the Federal objective, authorities and policies, is identified as the NER/Preferred Plan. The NER/Preferred Plan was determined to be Alternative 5. This plan provides a net gain of 340.47 AAHUs for an AA cost of \$680,393 and a total construction cost of \$ [REDACTED] (including base and contingency). Selecting the NER plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness.

An Environmental Assessment was completed for the proposed habitat restoration at Lockport Prairie Nature Preserve, Lockport Township, Will County, Illinois. The Environmental Assessment has concluded that there would be not be a significant effect on the human environment (no adverse affects), resulting from implementation of the NER/Preferred Plan. A 30-day Public Review period was held from 04 August 2015 to _____ 2015. Agency and public review comments will be addressed as they are received with pertinent comments incorporated into the document.

All significant aspects of the problems and opportunities as they relate to the LPNP study area's resource problems have been considered. Those aspects include environmental, social, cultural, and economic effects, as well as engineering feasibility. The National Ecosystem

Restoration (NER) Plan is Alternative 5, which consists of restoring native plant and fauna communities within LPNP project area. The NER plan has a Fully Funded Cost of approximately \$ [REDACTED] (2015 price levels). This plan provides 340.47 net average annual habitat units over 927.5-acres of the project area.

Chapter 1 – Introduction

1.1 – Report Organization

This Detailed Project Report (DPR) presents the results of the Lockport Prairie Nature Preserve (LPNP) Ecosystem Restoration study. This report consists of a main report with seven (7) chapters and ten (10) appendices (A-J) with figures and tables. The report is structured as follows:

Chapter 1 – Introduction: introduces the project and provides a description of the study area and a summary of relevant studies and projects completed

Chapter 2 – Inventory and Forecasting: contains an inventory or description of the study area which includes an assessment of pertinent historic, current and future without project conditions

Chapter 3 – Problems and Opportunities: discusses the problems within the study area, potential opportunities to remedy them, a study goal, restoration objectives and limiting constraints

Chapter 4 – Plan Formulation and Evaluation: discusses how plans have been formulated, presents the cost effectiveness and ecological benefits of each alternative, and discusses the evaluation process used to identify the National Ecosystem Restoration (NER) plan and select a recommended plan

Chapter 5 – Environmental Assessment: provides a description of potential impacts, both negative and positive, to cultural, ecological and physical resources within the surrounding environment and their significance.

Chapter 6 – Plan Implementation: discusses construction sequencing, monitoring and adaptive management, project costs and cost sharing responsibilities

Chapter 7 – Recommendation: provides the District Commander's recommendation for implementation of an ecosystem restoration plan

Appendix A – Hydraulics and Hydrology

Appendix B – Civil Design Sheets

Appendix C – Cost Engineering

Appendix D – Geotechnical Analysis

Appendix E – Hazardous, Toxic, and Radioactive Waste (HTRW) Report

Appendix F – Real Estate Plan

Appendix G – Compliance & Permit Information

Appendix H – Monitoring Plan

Appendix I – Current Conditions Biological Inventory

Appendix J – Habitat Assessment Results

1.2 - Study Authority

Water Resource Development Act, 1996 P.L. 104-303.SEC. 206. As amended. 33 US Code § 2330 AQUATIC ECOSYSTEM RESTORATION.

(a) GENERAL AUTHORITY.

(1) In general

The secretary may carry out a project to restore and protect an aquatic ecosystem or estuary if the Secretary determines that the project—

(A)

*(i) will improve the quality of the environment and is in the public interest; or
(ii) will improve the elements and features of an estuary) as defined in section 2902 of this title); and
(B) is cost-effective.*

(2) Dam removal

A project under this section may include removal of a dam.

(b) COST SHARING

(1) In general

Non-Federal interests shall provide 35 percent of the cost of construction of any project carried out under this section, including provision of all lands, easements, rights-of-way, and necessary relocations.

(2) Form

Before October 1, 2003, the Federal share of the cost of project under this section may be provided in the form of reimbursement of project costs.

(c) AGREEMENTS

(1) In general

Construction of a project under this section shall be initiated only after a non-Federal interest has entered into a binding agreement with the Secretary to pay the non-Federal share of the costs of construction required by this section and to pay 100 percent of any operation, maintenance, and replacement and rehabilitation costs with respect to the project in accordance with regulations prescribed by the Secretary.

(2) Nonprofit entities

Notwithstanding section 1962d-5b of title 42, for any project carried out under this section, a non-Federal interest may include a nonprofit entity, with the consent of the affected local government.

(d) COST LIMITATION

Not more than \$10,000,000 in Federal funds may be allotted under this section for a project at any single locality.

(e) FUNDING

There is authorized to be appropriated to carry out this section \$50,000,000 for each fiscal year.

1.3 – Study Purpose & Background

Prairie communities characterized by shallow soil over dolomite bedrock in Northeastern Illinois are recognized as globally unique and very rare. Wet and wet-mesic dolomite prairies are among the most critically imperiled natural communities on earth, with a global rank of

G1, in great danger of extinction, (NatureServe, 2014) and currently are found only in the lower Des Plaines River active floodplain in Illinois. Around 45 acres of dolomite prairie (at different levels of quality) remain in Illinois (CTAP, Lower Des Plaines, 2003). At this time, there are approximately 19-acres of dolomite prairie at LPNP.

In addition to the vulnerable ecosystem, LPNP supports 3 Federally-listed species: the Leafy Prairie Clover (*Dalea foliosa*) and Hine's Emerald Dragonfly (*Somatochlora hineana*), and the Lakeside Daisy (*Actinea herbacea*). In the last 10 years there has been a significant decline in the reproductive output of the Hine's Emerald Dragonfly at Lockport. One concern is the change in the quantity and quality of groundwater discharging into the wetland areas that support the rivulet dependent larvae of the Hine's Emerald Dragonfly. High quality groundwater discharges from along the bluffs forming slow flowing seeps, called rivulets. Another result from the change in groundwater discharge has been a decline in the population of Leafy Prairie Clover, another vulnerable hydrophytic species inhabiting the wet and wet-mesic prairie. Other threats to federally protected species include invasive species, surface water runoff and development of the watershed.

While Lockport Prairie is managed by qualified personnel and legally protected, a change in land use and installment of recent wells have changed the hydrology of the site's watershed. A critical factor sustaining the integrity of the wet prairie and the federally listed species is water quality and quantity in terms of the groundwater discharging from the seeps and surface water runoff. Without proper restoration and protection of the site's water sources almost all other management actions would have little effect in stopping or reversing the decline in the quality of Lockport Prairie and the populations of the federally protected species.

This Section 206 Aquatic Ecosystem Restoration study was requested by the Forest Preserve District of Will County (FPDWC) with the purpose to evaluate the feasibility and environmental impacts of restoring and protecting the hydrology of the Lockport Prairie watershed and the important diverse and unique plant communities. The scope and need of this study addresses the issues of altered hydrology, degraded wetland areas, invasive species, wetland/prairie grassland bird nesting structure, native species richness and encouragement of public education. This feasibility study will assess and identify problems and opportunities, identify and evaluate measures, and recommend the most cost effective solution to the ecological problems that have the potential to extirpate the globally important ecosystem and three endangered species from this area.

1.4 – Study Area

The LPNP watershed is located in Lockport Township, Will County, Illinois (Figure 1). The 927.5-acre study area is bordered by Route 7 to the north and the Des Plaines River to the east. Will county is a mixture of residential, industrial and agricultural development. Predominant land use is agricultural, mostly corn and soybeans. The LPNP watershed is also a mix of residential, industrial and agriculture. The LPNP watershed has been undergoing an increased rate of land use conversion from agriculture to residential. LPNP is bordered by Des Plaines River to the east. The Des Plaines River flows into the Illinois River that then discharges to the Mississippi River and eventually into the Gulf of Mexico. PBP surface water primarily flows into drainage tiles and artificial ditches that then discharges into the Des Plaines River as well.

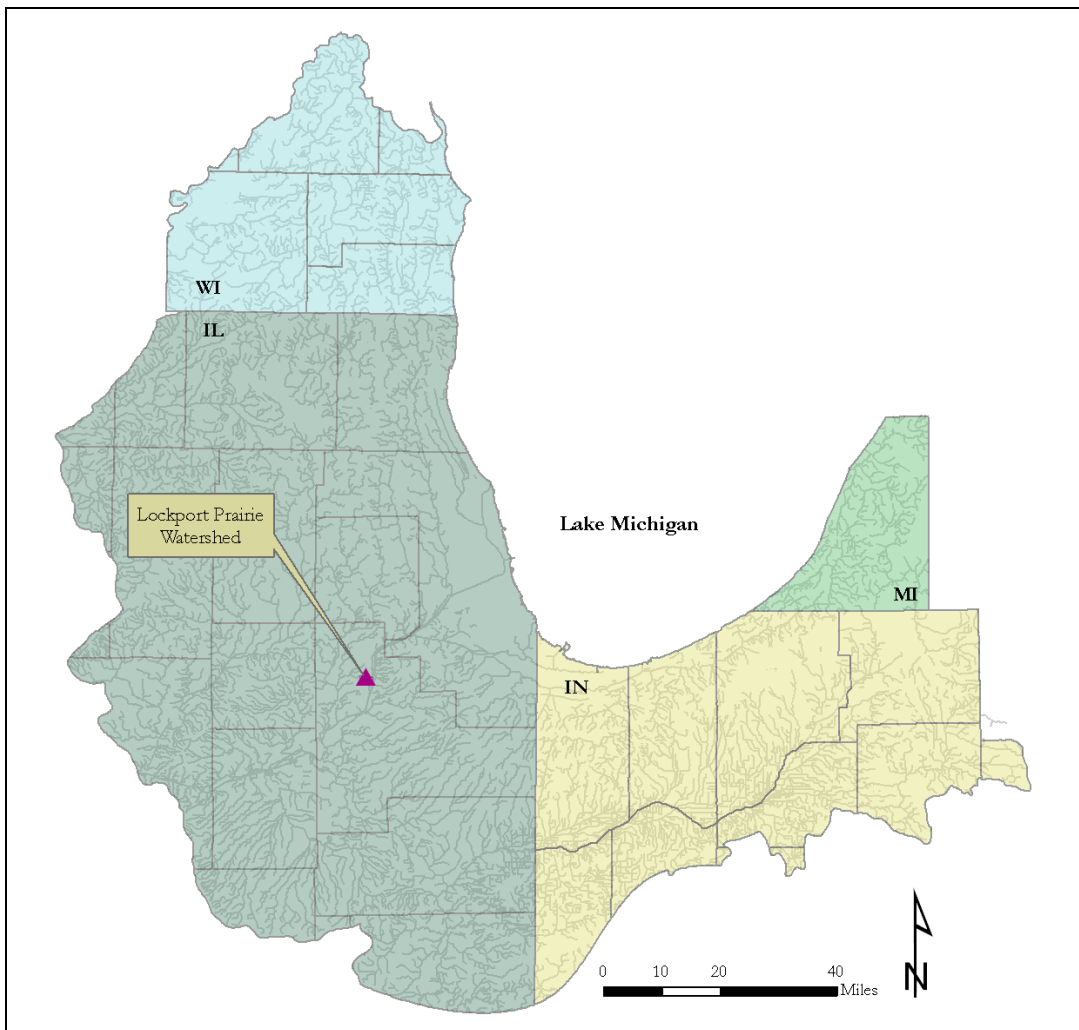


Figure 1. Location of Lockport Prairie.

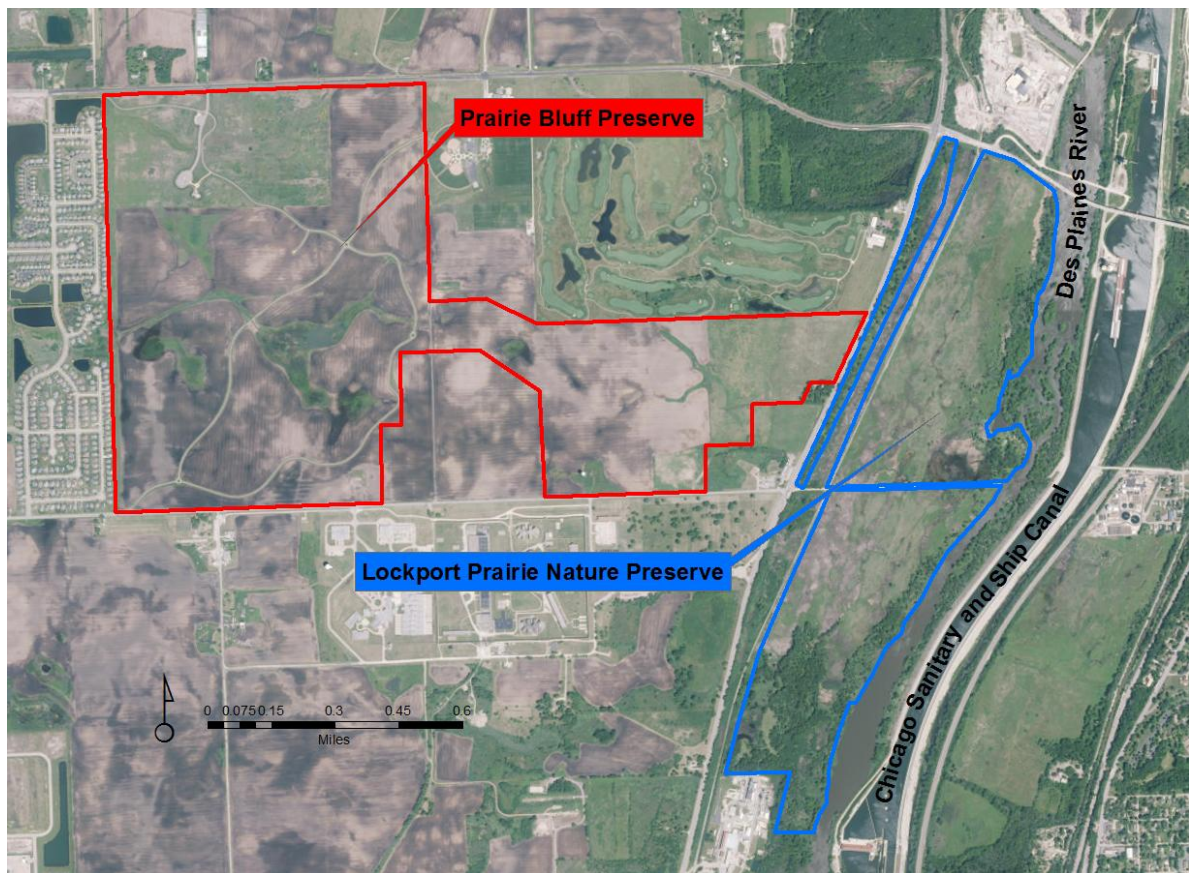


Figure 2. Location of Lockport Prairie within Chicago Region.*

**Lockport Prairie Nature Preserve has been delineated as Critical Habitat for the Hine's Emerald Dragonfly by the U.S. Fish and Wildlife Service. Prairie Bluff is not Critical Habitat, but plays a significant role in the groundwater recharge zone of Lockport Prairie Nature Preserve that supports habitat for the Hine's Emerald Dragonfly.*

5 – Pertinent Reports, Studies & Projects

LPNP has been the subject of numerous studies and projects to date that have focused on the changes to the functional integrity of the site. Below are detailed summaries on six studies which were pertinent for the development of this feasibility study. Following the detailed summaries are additional studies which were reviewed. Studies indicated with an asterisk (*) were fully or partially funded by the USACE.

Hine's Emerald Dragonfly Habitat Assessment*

The following summary was based on information contained in the Soluk, et al. (2006) report. Larvae were sampled in the wetland areas (rivulets) at Lockport Prairie Nature Preserve to define the relationship between patterns of seasonal drying and larva abundance. Streamlet 2N had the highest number of larva present and was the most productive out of the other rivulets in Lockport Prairie (806 individuals in 2003). However, the mean stream density was lower than other rivulets at 3.34 larvae/m². Although in the last year sampled, in 2004, only 100 *Hine's Emerald Dragonfly* larvae older than one year old were found in 2N. A dry year occurred in 2003 and could be the reason for the significant drop in production in the rivulets.

Quantitative measurements and professional observations of the water levels in the rivulets has uncovered a disturbing trend of earlier and more prolonged periods of dry conditions, which is correlated to a decrease in the number of larvae sampled at Lockport Prairie. Future trends of the population of Hine's Emerald Dragonfly at Lockport Prairie are predicted to decrease.

Hydrologic Assessment*

The following summary was based on information contained in the Graef, Anhalt and Schloemer (2002) report. Since hydrology is the driving force behind the species composition and uniqueness of Lockport Prairie, this study looked at the hydrology of the site in terms of natural and anthropogenic influences, as well as, intricate surface and groundwater interactions. Boundaries of basins and sub-basins were delineated within and surrounding the study area. The area was divided into 6 hydrologic units. Units were described in terms of sources of water entering the basin and where the water exited the basin. Sources of water entering the basin came from runoff from the surrounding watershed, precipitation, groundwater seepage that becomes rivulets, groundwater discharge directly into the prairie areas and overflow from the Des Plaines River. Surface water flow was also monitored for a period of time with a goal of generating a hydrologic model to be able to more accurately describe the existing conditions and anticipate how changes to the water regime within the preserve might affect water balance and hydrology

Hydrogeologic Assessment*

The following summary was based on information contained in the Graef, Anhalt and Schloemer (2002) report. This study looked at the sources of groundwater, how groundwater entered the study area and determined the sensitivity of the groundwater supply to change from both natural conditions and human activities. Soils samples, groundwater elevations taken from monitoring wells and data from precipitation events were used to determine the direction and volume of groundwater flow entering the area. The general direction of groundwater flow is from west to east towards the Des Plaines River (point of discharge). The area of groundwater recharge for the study area was delineated and covered ~2.57 square miles. Differences in the type of geologic materials overlaying the bedrock caused variations in the rate of infiltration and subsequently the amount of water recharging the aquifer. The groundwater supply to the study area is very susceptible to negative impacts from human activities because the area of recharge for water entering the prairie is relatively small and the recharge rate of groundwater for much of the recharge zone is very low. Human activities are defined as converting pervious surfaces into impervious surfaces (e.g., parking lot) or groundwater diversions, such as new wells or quarrying activities.

Vegetation Analysis*

The following summary was based on information contained in the Conservation Design Forum (2003) report. The purpose of this study was to map the plant communities and quantify the quality of said communities. The map was then compared to previous inventories to detect changes in quantity and quality of rare the plant communities. The results display two distinct trends within the study area. Some communities were shown to have improved in quality with an increase in the number of native species, while other communities experienced a decline in floristic quality. Changes in the management regime that required the removal of the dominant non-native shrub species was probably the cause of the increased quality of select communities. Conversely, communities declining in quality experienced encroachment by surface water runoff and floodwaters from the Des Plaines River. The conclusion of the report

states that the rare plant communities located within Lockport Prairie are threatened to the extent to which Lockport Prairie's water source is threatened.

Land Use Analysis of the Recharge Area*

The following summary was based on information contained in the Graef, Anhalt and Schloemer (2005) report. Current land use was mapped within and surrounding the groundwater recharge area of Lockport Prairie. Trends in the surrounding area's human population and plans for future development were used to predict future land uses and how this may affect the water supply to the study area. Based on the subsurface geology, average municipal well pumping, amount of impervious surfaces, municipal master development plans and estimations of water consumption rates, future conditions could significantly threaten the continued function of the recharge area in sustaining the necessary hydrologic conditions for continued floristic quality of Lockport Prairie. Future conditions are predicted to include the installation of more wells and higher pumping rates. Recommendations from the report include the formation of a recharge area management committee that would be in charge of encouraging water conservation and advising local communities and the installation of storm water infiltration basins and the inclusion of Best Management Practices into local ordinances.

Soil Mapping

The following summary was based on information contained in the Dr. Thomas Simpson, Northeastern Illinois University, (2001) final report. In many areas, there has been the formation of a deeper A-horizon, especially in fissures in the dolomite, high in organic matter content, which suggests that soil wetness is a feature throughout LPNP even during the hot summer months. There is a general lack of a distinct E-horizon (i.e., a mineral horizon in the upper part of the soil) in the soil profile, a zone that usually is marked by relatively acidic conditions and results from the eventual damping of excess calcium and magnesium ions. This process does not occur at Lockport Prairie because much of the remnant landscape is under the influence of an upwelling of bicarbonate-rich groundwater. Related to this is the fact that the graminoid vegetation acts as a nutrient pump by removing calcium and magnesium ions from deeper soil zones and moving them upward to be incorporated into their roots and leaves. Upon senescence of the plant parts, the nutrients are released again on the surface or into the shallow soil zone.

Additional studies

1994. Vogt, T.E. and E.D. Cashatt. Distribution, Habitat, and Field Biology of *Somatochlora hineana* (Odonata: Corduliidae). *Arthropod Biology*. 87(5):599-603.

2001. The Forest Preserve District of Will County. Preliminary Restoration Plan for Prairie Bluff Preserve.

2001. Simpson, T.B. Soil Mapping at Lockport Prairie. Department of Geography, Northeastern Illinois University.

2002*. Graef, Anhalt Schloemer & Associates, Inc. Lockport Prairie Nature Preserve Ecological Assessment, Surface Water Hydrology Investigation. Prepared for The Forest Preserve District of Will County.

- 2002*. Graef, Anhalt Schloemer & Associates, Inc. Lockport Prairie Nature Preserve Ecological Assessment, Hydrogeological Investigation. Prepared for The Forest Preserve District of Will County.
- 2002*. Soluk, D.A., and K. Moss. The distribution and quality of Hine's Emerald Dragonfly habitat in relation to surface and groundwater dynamics in the Lockport Prairie Preserve. CorLands, Chicago, IL and USFWS, Barrington IL.
- 2003*. Norris & Associates. Data Collection and Hydrologic Model Report for the Lockport Prairie Nature Preserve. Prepared for USACE – Chicago
- 2002*. USACE, Chicago District. Lockport Prairie Preliminary Restoration Plan (PRP).
- 2003*. Conservation Design Forum. Lockport Prairie Nature Preserve Vegetation Analysis. Prepared for The Forest Preserve District of Will County.
- 2004*. Graef, Anhalt Schloemer & Associates, Inc. Lockport Prairie Nature Preserve Ecological Assessment, Gap Analysis Summary and Fauna Analysis. Prepared for The Forest Preserve District of Will County.
- 2004*. Soluk, Hoekstra and Moss. Habitat Parameters of the Hine's Emerald Dragonfly: Using Temperature Loggers to Assess Hydrological Regime in Wetlands Supporting the Larval Stages. Prepared for USACE Chicago
- 2005*. Soil Investigation, Lockport Prairie. Bramstedt, M.W. USDA NRCS.
- 2005*. Graef, Anhalt, Schloemer and Associates. Land Use Analysis: Lockport Prairie Recharge Area. Submitted to Forest Preserve District of Will County, Joliet, IL
2006. US Fish and Wildlife Service Public Hearing on the Designation of Hine's Emerald Dragonfly Critical Habitat. Romeoville recreation Center. USFWS, Chicago Office.
2006. The Forest Preserve District of Will County. Goals for Lockport Prairie Nature Preserve.
- 2006*. USACE, Hydraulic Engineering Center. Hydrologic and Hydraulic Modeling Recommendations for the Lockport Prairie Environmental Restoration Project. Chicago District, Chicago, IL.
- 2006*. Soluk, D.A., Satyshur, C., Holmes, J. and E. Blas. The distribution and quality of Hine's Emerald Dragonfly in relation to surface and groundwater dynamics in the Lockport Prairie Nature Preserve. Final Report, submitted to the Corporation for Openlands, Chicago, IL
- 2014*. Wildlife Hazard Assessment and Management Plan. The predicted responses of the priority wildlife species that are of concern to the FAA were assessed regarding restoration of LPNP and PBP.

Chapter 2 – Inventory and Forecasting

Consideration of ecosystems within or encompassing a watershed provides a useful organizing tool to approach ecosystem-based restoration planning. Ecosystem restoration projects that are conceived as part of a watershed planning initiative or other regional resources management strategies are likely to more effectively meet ecosystem management goals than those projects and decisions developed independently. Independently developed ecosystem restoration projects, especially those formulated without a system context, partially and temporarily address symptoms of a chronic/systemic problem. The following chapter outlines the past, present and future without-project conditions of LPNP and PBP.

2.1 – Current Conditions

The LPNP and PBP study area is diverse, comprised of marsh, rivulet, prairie, savanna, and forest. Certain wetland habitats are becoming increasingly rare along with the species that are reliant on them, and in particular fen and rivulet habitat. The spatial extent of native plant communities is still present; however the pressure from anthropogenic sources has led to the deterioration of physical conditions. This degradation in physical habitat structure has caused a marked decline in both species richness and abundance of native animal and plant assemblages and the federally endangered Hine's Emerald Dragonfly.

2.2 – Physical Resources

2.2.1 – Climate

The climate in northeastern Illinois is classified as humid continental, characterized by warm summers, cold winters, and daily, monthly, and yearly fluctuations in temperature and precipitation. Average annual rainfall is usually between 30 to 40 inches per year, with greater proportions falling between April and August. Seasonal snowfall averages about 28 inches annually. Early spring floods occur when snow accumulations extend into a period of increasing temperature that results in melting.

2.2.2 - Topography

The Chicago region is relatively flat, with flat to rolling elevations. The project area differs greatly from the typical scenario, with an almost flat glacial till plain (PBP) on the west half of the project, formed by the final stages of the Wisconsin glacialation meltdown, 14,000 years ago. This plain abruptly drops 50-60 feet down a rocky slope to the fluvial floodplain of the Des Plaines River, which is primarily bedrock covered with a thin layer of natural soils and fluvial deposits (LPNP). On the north-south axis the project area has a slight slope to the south. Within the river valley lie narrow elevated deposits of gravel and rock that run longitudinally from north to south.

2.2.3 - Geology

The ecology of LPNP is significantly influenced by the glaciofluvial formed landscape, which deposited a blanket of unsorted debris over most of the region that includes clay, sand, gravel, and boulders, collectively called glacial till. Around 15,500 years ago, glaciers to the north and east of the Kankakee area began to melt very rapidly. Lobes of ice were in areas now occupied by Lake Michigan, the State of Michigan, and eastern Indiana. Melt waters were pooled by moraines to the south, and huge lakes formed, but not for long. The moraines were breached, and the result was among the greatest floods of the Pleistocene Epoch, the Kankakee Torrent. This great flood scoured the old river valley down to the Niagaran dolomite bedrock in the study area. This action peeled off large chunks of dolomite, and left behind bars of rock and gravel in the floodplain that are now dolomite prairie (Willman 1971). The force of the water also deposited a steep layer of sand, gravel, and rock along the valley wall called the Henry Formation that now acts as a conduit for the ground water that discharges into the prairie from along the bluff. Above the valley terrace, on the western half of the project area, the 20 foot deeper layer of fine till slows percolation down to the bedrock, although water that infiltrates there also discharges into the prairie as well, principally into the river valley.

PBP consists of gently rolling topography with associated wetland swales. There is a prominent east-facing slope in the southeast portion of the site. The topographic relief is about 70-feet, with the high point (670-feet) near Renwick and Wilco roads in the northern portion of the site, and the lowest point (600-feet) near Route 53 and Division Street in the southeast portion of the site. Subsurface flows under the entire project site flow eastward toward LPNP and the Des Plaines River. A series of linear fractures within the underlying limestone bedrock are believed to channel flows to rivulets within LPNP.

2.2.4 - Soils

Soils generally are thin within the LPNP and in places the fine-textured yellow weathered dolomite, is exposed as chunks, flags, and solid bedrock, is exposed. Only in seismic fissures do the soils deepen to more than 1-2 feet. In those fissures alluvial deposits are replaced by more organic deposits, which were formed from dead vegetation that could only partly decompose because of the upwelling of ground water.

Based on the U. S. Department of Agriculture National Resources Conservation Service (NRCS) soil map for the LPNP, the soils are predominantly Romeo, an alluvial soil shallow to bedrock. In many areas, there has been the formation of a deeper A-horizon, especially in fissures in the dolomite, high in organic matter content, which suggests that soil wetness is a feature throughout LPNP even during the hot summer months. There is a general lack of a distinct E-horizon (i.e., a mineral horizon in the upper part of the soil) in the soil profile, a zone that usually is marked by relatively acid conditions and results from the eventual damping of excess calcium and magnesium ions. This process does not occur at LPNP because much of the remnant landscape is under the influence of an upwelling of bicarbonate-rich groundwater. Related to this is the fact that the graminoid vegetation acts as a nutrient pump by removing calcium and magnesium ions from deeper soil zones and moving them upward to be incorporated into their roots and leaves. Upon senescence (e.g., dying back at end of season) of the plant parts, the nutrients are released again on the surface or into the shallow soil zone.

The eastern edge of LPNP has soils developed on top of very permeable sand and gravel outwash from fluvial processes of the Des Plaines River, while the western portion of LPNP has soils developed on less permeable silty clay till from glacial processes. Soils are all

underlain with fractured dolomitic limestone bedrock. The site is composed of approximately 99.9% hydric soil and a small portion of the soil disturbed by human activities. PBP displays the same pattern of soil types although much more diverse in the number of soil types. Approximately 100% of the soil types mapped by the NRCS at PBP are listed as hydric or having hydric inclusions. Soils within the PBP reflect the glacial history of the area. Soils are also all underlain with fractured dolomitic limestone bedrock.

Soil quality, defined as the ability to sustain diverse native plant communities, is intact within LPNP. This is the result of low levels of human activities within the preserve over the last 100 years. Soil quality within PBP has been impacted by many years of agricultural production that have resulted in a highly disturbed upper 12 inches of soil overlaying a lightly compacted layer.

2.2.5 – Surface & Ground Water Hydrology

The complex interactions of water and the environment are in large part responsible for the study area's rarity and uniqueness. The specific hydrologic regime of the study area creates the conditions necessary for the habitation and reproduction of the endangered Hine's Emerald Dragonfly, as well as, the unique composition of plant species that occur at the site. The hydrologic regime is complex and warranted considerable monitoring efforts. The information compiled through personal observation and quantitative measurements describes a site with numerous sources of surface water interacting with various areas of groundwater discharge. The natural surface hydrology was altered through the installation of the north-south oriented railroad and the east-west oriented Division Street. To better understand the interactions occurring on the site drainage, basins were delineated (basins A through F) (Figure 3). The hydrology was examined between and among drainage basins.

It appears that in the last 5-10 years there has been a change in the surface and groundwater hydrology at the site in terms of the water quantity and quality. This change appears to have adversely impacted several threatened and endangered species, including the Hine's emerald dragonfly. The Hydrologic and Hydraulic Appendix documents the hydrologic engineering analysis undertaken for this ecosystem restoration project.

Understanding the hydrology of the site is critical because of the connection between water and the endangered species, which have been showing signs of distress believed to be caused by changes in the hydrology. The Hine's Emerald Dragonfly has very specific environmental conditions that must be met for successful reproduction to occur (refer to Figure 3 for location of rivulets). These conditions include enough high quality groundwater discharge at a rate to create small, slow moving rivulets through herbaceous marsh and wet prairie, which then dries up for a small portion of the year. Too much water at too high a flow rate or not enough water for a long enough period correlates to a higher mortality rate of the larvae.

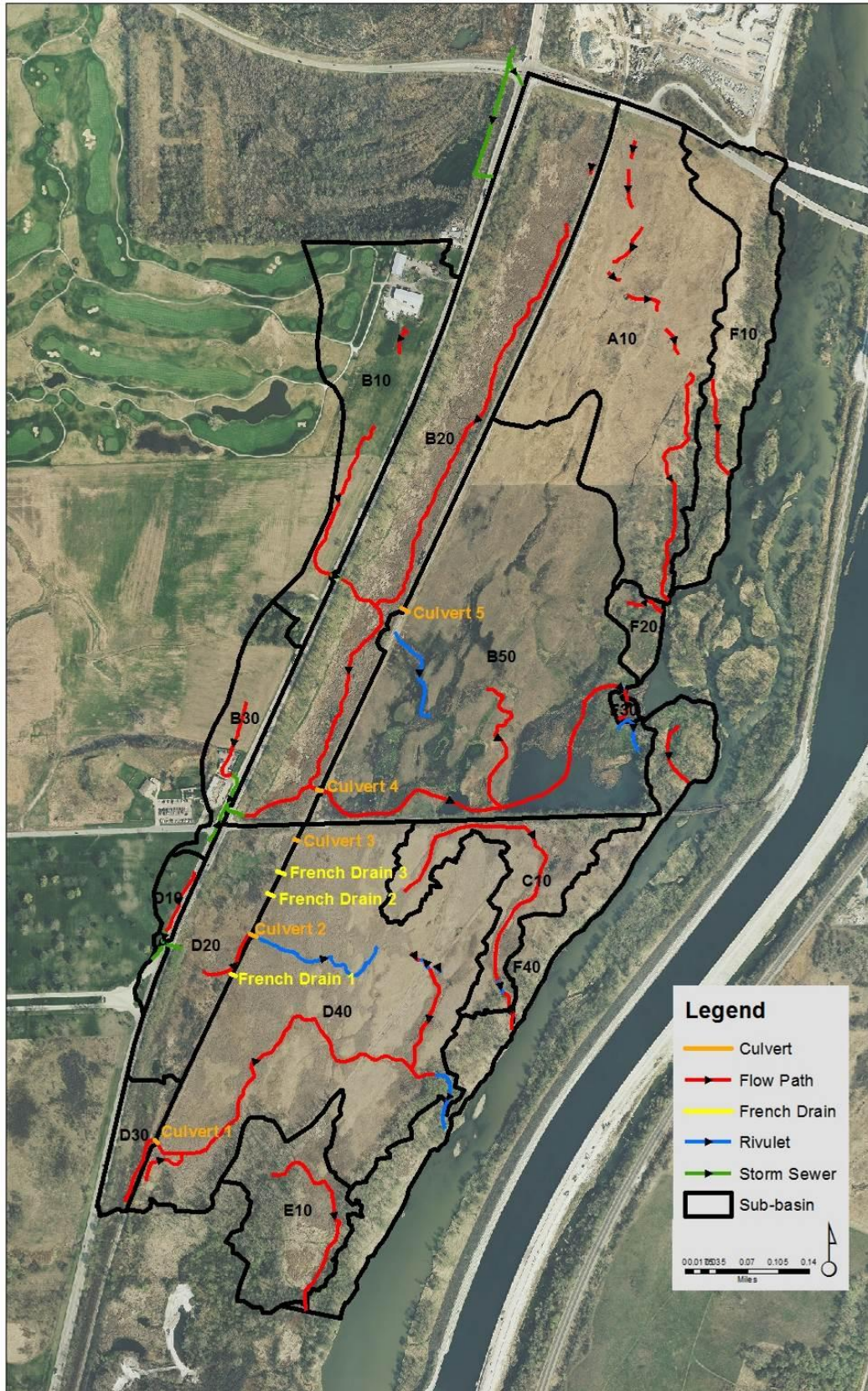


Figure 3. Map of LPNP Drainage Basins and Rivulets (Critical Habitat)

The hydrologic analysis of this project had two objectives: to understand the sources of water and the way it flows on the site, and to investigate some of the proposed measures to support the alternatives analysis. A water balance was performed for a portion of the site. Overall, LPNP receives water from these sources:

- Runoff from the upstream watershed,
- Precipitation directly into the preserve,
- Groundwater seepage that becomes surface flow,
- Groundwater discharge within the prairie, and
- Floodwaters from the Des Plaines River

The period of record analyzed was limited by the availability of monitoring well observations. Since only four calendar years were included in the balance, one cannot draw conclusions about long-term trends or changes in the site hydrology. However, the water balance results provide greater insight into how water enters and moves at LPNP.

Basins A through F were delineated based on where the water flows into the area and where it flows out of. Basins are mapped in Figure 3. Basin B is located along Route 53 along the northwestern border of LPNP and flows into the interior of the site. Basin D is located to the south of Basin B. Basin B and D are connected through a culvert under Division Street. These are important basins because the Hine's Emerald Dragonfly habitat is found within these basins.

Data from the entire period of record and both Basins B and D were combined. On average, the volume of groundwater entering the site is slightly greater (56%) than the volume of precipitation (44%). Almost two-thirds of the outflow from the basins leaves as surface runoff. Evapotranspiration accounts for less than one-third, and deep percolation accounts for 4%. The average change in soil water storage was negligible for the period of record because every time the soil dried out, it became saturated again within a few months. The amount of runoff entering the prairie is about 54 inches per year.

2.2.6 - Hydrogeology

The following is a summary of the LPNP Hydrogeology Report 2004. The significance of groundwater discharging from the dolomite aquifer, containing significant amounts of calcium and magnesium, on the inhabitants of LPNP cannot be overstated. The general direction of groundwater movement is from northwest to southeast, moving toward the Des Plaines River, within the study area. A groundwater divide (e.g., groundwater flow is directed in two different directions) occurs around three miles to the west of the site where groundwater flows both east and west, with the groundwater moving westerly eventually discharging into the DuPage River. The area of groundwater origination and flow is measured around 2.57 square miles and is referred as the area of groundwater recharge for LPNP (Figure 4). Within the recharge area there are three distinct types of geologic materials that transmit groundwater to the study area. At the base of these formations is the Silurian Period dolomite bedrock of the Niagaran Series.

On top of the bedrock are deposits from glacial actions, the last glacier retreated approximately 12,000 years ago. The majority of the area is covered by the Wadsworth Member of the Yorkville Till that consists of glacial moraine deposits of silt, clay and sand till. The second type of glacial deposit overlaying bedrock is the Henry Formation, which is composed of sand

and gravel outwash. The Henry Formation forms a thin irregular band that overlays the area along the bluffs and extends west for about 1/4 mile. Transmission of water vertically and horizontally through the Yorkville Till is very slow because of its low permeability, versus the Henry Formation, which transmits water easily and has a high permeability. The Yorkville Till also slowly transmits water laterally into the Henry Formation. Groundwater discharge along the bluffs forms the seeps that flow from the Henry Formation. Because of the member's high permeability it is highly influenced by precipitation and can quickly reach saturation within the upper surfaces of the dolomite near the bluffs. These seeps feed the rivulets, which sustain the Hine's Emerald Dragonfly population at LPNP. Within LPNP, groundwater discharge from the underlying dolomite bedrock remains much more stable and does not show the same sensitivity to fluctuating rain events as the Henry Formation does, which influence the water levels of the seeps. This indicates areas within LPNP, not considering the seep/rivulet systems, are receiving a constant source of groundwater to the thin alluvium overlaying the dolomite bedrock. Figure 4 depicts the groundwater recharge zone for LPNP, which encompasses much of PBP.

The predominant land use in the recharge zone is agricultural (PBP), which allows a certain degree of water infiltration to the subsurface. Land currently in residential or commercial uses, which are a low percent of land use within recharge zone, has a relatively lower infiltration potential than agricultural land as a result of hard impervious surfaces. The ideal recharge surface would be composed of deep rooted native vegetation with natural unaltered hydrology (i.e., no drain tiles). Additionally, a municipal well in a nearby township has drawn down the dolomite aquifer 50 to 60 feet below natural levels because the well is pumping out more water than the surrounding recharge area can replenish the aquifer. These are referred to as areas of groundwater depression. Current conditions of the recharge zone are the result of past human activities that have reduced the infiltration potential and as a result are having an impact on the groundwater fed seeps and rivulets within LPNP. The groundwater supply is critical to the survival of several rare and endangered plant and animal species at LPNP.

Currently, there is a process of close coordination between local municipalities and the U.S. Fish and Wildlife Service for any new wells or operational changes to current wells that is designed to ensure that groundwater flow is not diverted from LPNP. In addition, USFWS is coordinating with local industry to ensure current and future quarrying activities do not disrupt groundwater hydrology within LPNP and other known Hine's Emerald Dragonfly habitat units in the Lower Des Plaines River. In addition, the FPDWC, as the lease holder for the current farming activities in PBP, has control over the type and rate of pesticide application at PBP. The FPDWC has reviewed and approved a list of herbicides that have been shown to have the least impact to groundwater in terms of breaking down quickly after application.

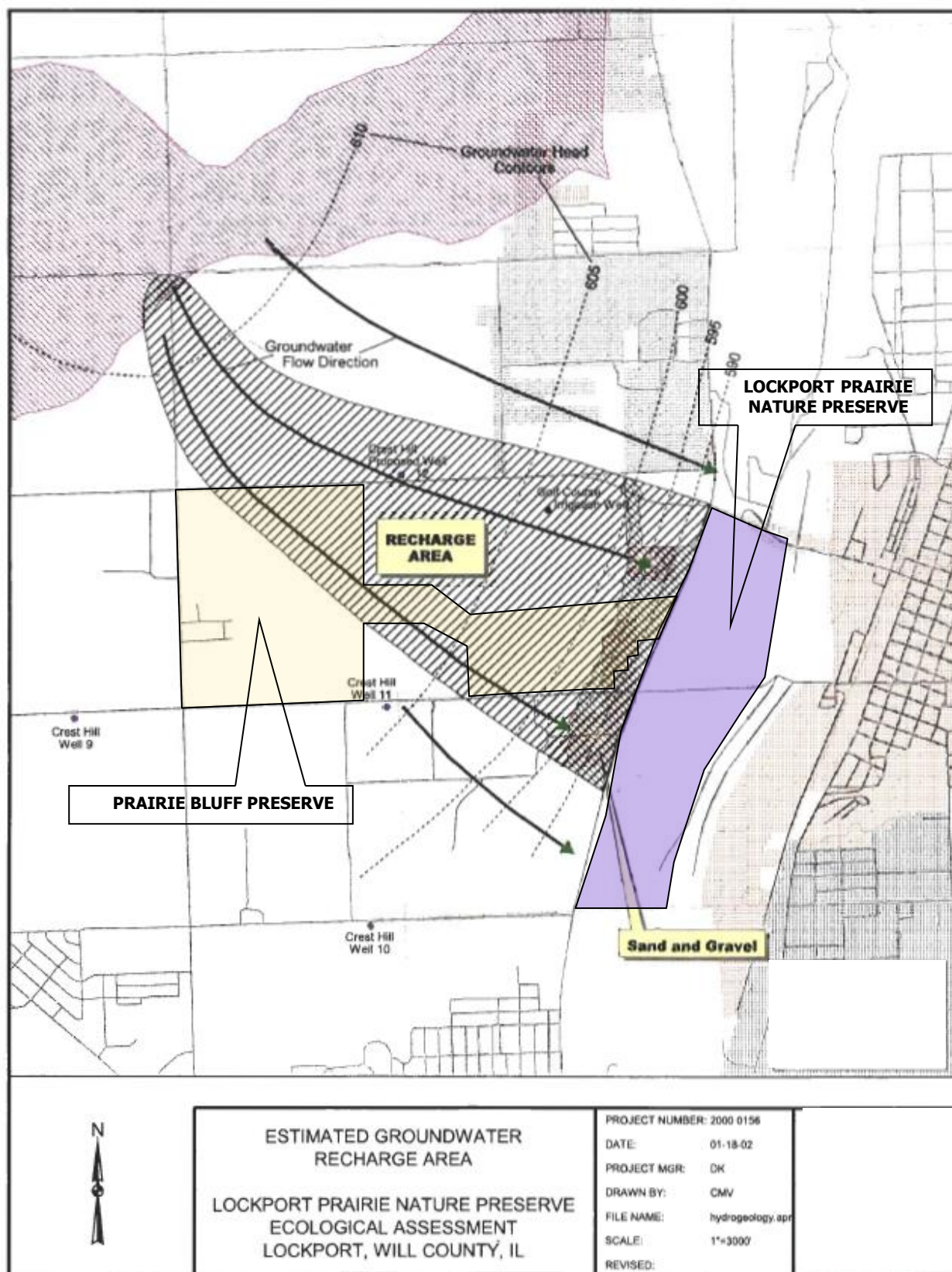


Figure 4. Groundwater Recharge Zone for Lockport Prairie Nature Preserve

2.2.7– Hazardous, Toxic & Radioactive Waste (HTRW) Analysis

USACE conducted an initial Phase I Environmental Site Assessment (ESA) in accordance with ASTM E-1527-13. According to ER 1165-2-132, non-HTRW environmental issues that do not comply with federal, state, and local regulations should be discussed in the HTRW evaluation along with HTRW issues. The HTRW assessment included in Appendix E was completed using information provided by the FPDWC, review of existing information, historical documents and aerial photographs, database research, and a site visit. No recognized environmental conditions (RECs) were identified in the ESA; however, the ESA identified one non-HTRW issue at the project site. The area of the Prairie Bluff Preserve site that contained a previous residential structure along Division Street appears to have a combination of concrete rubble and asphalt on the soil surface, likely remnants of the previous structure. If removal of the material is required for establishing vegetation in the area, the material should be disposed as clean construction and demolition debris (CCDD) at a registered CCDD waste site.

2.3 – Ecological Resources

The following is a description of the community types that occur within the study area of this project. Dominant vegetation and organisms that inhabit the particular community will be presented to paint a contextual picture that relate to the restoration alternatives investigated under this study.

Ecosystem is a term used to describe organisms and their physical and chemical environments and can be described and delineated at various scales. For example, a pond or an ocean can be equally referred to as an ecosystem. Communities are naturally occurring groups of species that live and interact together as a relatively self-contained unit, such as a cobble riffle. Habitat refers to the living space of an organisms or community of interacting organisms, and can be described by its physical or biotic properties, such as substrate, woody debris or depression. Ecosystems may contain many communities and habitat types. These are usually assessed by describing and/or quantifying the physical structure, function, and/or present biological assemblages contained in the area of interest. They may also be assessed at various scales, depending on the level of resolution needed to answer specific questions. To achieve the objectives of the proposed project, the different types of ecosystems or communities contained in the study area were described and delineated based on their respective geomorphic position, dominant species assemblages, and physical structure of respective habitats.

General Land Office Survey Notes (1821) described the LPNP area as rolling prairie that extended to the west from the Des Plaines River. An 1865 painting (Figure 4) shows cattle grazing on the site and a trail in the same location as today's walking trail, along a ridge that bisects the site longitudinally. In 1976, Illinois Natural Areas Inventory (INAI) surveyors noted that livestock had grazed Lockport Prairie, particularly the upland portions. The surveyors described existing ridges as having been used as haul roads for the quarrying of flagstone along the Des Plaines River. Despite the past abuse of this landscape, the INAI surveyors identified the prairie as "about the best remaining ... limestone prairie of its type." Appropriately, Lockport Prairie was dedicated as an Illinois Nature Preserve in 1983.



Figure 5. Lockport Prairie Nature Preserve Picture
(Wet prairie in foreground and floodplain forest in background)

2.3.1 – Plant Communities

Plant community structure and function form the base of the food chain and is one of the primary drivers of nutrient cycling in almost all ecosystems. Plant communities influence all other trophic levels within an ecosystem, including arthropods, insects, amphibians, fish, birds and mammals. Plant communities also indicate past historical uses and disturbances within an area. The following sections detail past disturbances and current conditions of the plant communities within the project area.

A large area of European buckthorn (*Rhamnus cathartica*) became established throughout the drier portions of the prairie by the mid-1980's. This discovery was important in compelling the FPDWC to begin a management program. Today, due primarily to the FPDWC's ongoing efforts, Lockport Prairie includes good quality patches of Dolomite Prairie as well as the federally listed species mentioned above. Regular prescribed fire and other small scale maintenance attempt to keep the cover of non-desirable woody species to a minimum.

The following information was distilled from 3 reports: the Illinois Natural Areas Inventory of 1976-1977 (INAI); a survey conducted in 1986 by Marcella DeMauro of the FPDWC; and a survey done by Dr. Gerould Wilhelm of Conservation Design Forum in 2002. Additional information was gathered by a USACE staff member and Dr. Wilhelm in 2006 and 2014.

A complex mosaic of plant communities can be found throughout the site (Figure 6). They range from commonplace, degraded communities such as Floodplain Forest, to the globally endangered Wet Dolomite Prairie. They occupy a hydrologic gradient from dry to riverine marsh. It is estimated that 330 vascular plant species inhabit the area.

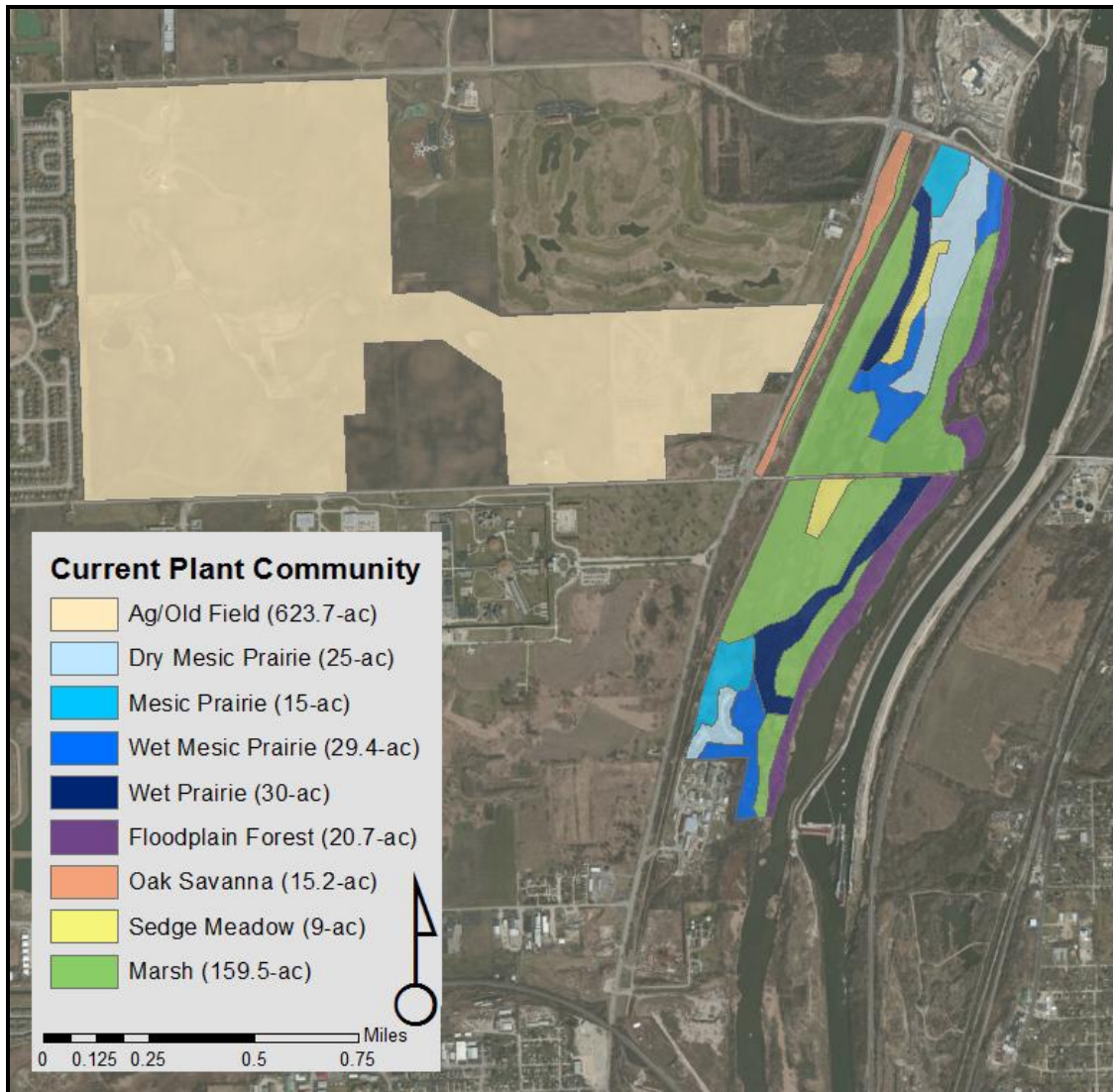


Figure 6. Location of Current Plant Communities

Agriculture/Old Field

The current and former agricultural fields are located in the PBP portion of the project area. This plant community encompasses 623.7-acres. Prior to settlement this area was predominantly a mosaic of mesic prairie and emergent marsh. This area was then plowed under and farmed. A series of drain tiles were installed to drain away excess water to increase production of agricultural commodity products, most recently corn and soybeans. The current plant community is dominated by non-native species and provides extremely low quality wildlife habitat. This area is located within the critically important ground water recharge zone of the LPNP. The change from deep rooted native plants to annual row crops and the installation of drainage tiles has greatly changed the structure and function of this area. The

area is now much drier and does not retain as much water, thereby altering the amount of water able to infiltrate to the groundwater table. Past farming practices has altered the soil properties as well. The act of adding fertilizer and continuous disking every year has resulted in a layer of compaction located about 6-12 inches below the surface. This compaction acts as an impermeable layer, further reducing the amount of water that can infiltrate to the ground water table. Dominant plants include, Corn (*Zea mays*) coefficient of conservatism (C) value of 0, Soybeans (*Glycine max*) C of 0 and Tall goldenrod (*Solidago altissima*) C of 1. The mean conservatism value of this plant community is **0.42**. This indicates that the community holds little to no value for native wildlife species and is considered to represent the most degraded category of plant communities within the Chicago Region. For further information about the coefficient of conservatism or the mean conservatism value or the Floristic Quality Assessment see Chapter 3, Habitat Assessment Methodology.

Prime and Important Farmland

An investigation into the characteristics of the farmland in PBP included consulting the map of prime farmland or important farmland within the state of Illinois created and published in October 2009 by the Natural Resources Conservation. No prime or important farmland is located in PBP.

Marsh (Pond, spring and Phragmites)

The remaining marsh plant community is located within LPNP within low lying areas where water is able to pool and remain for most of the year. The marsh has and continues to undergo a slow shift from dominance of native plant species to dominance of non-native and aggressive native plants, namely Common reed (*Phragmites australis*) and Narrow leaf cattail (*Typha latifolia*). Understanding this shift is critically important for the Hine's Emerald Dragonfly, which has breeding habitat within these areas and in areas identified as sedge meadow. The reason for the shift from dominance of native to non-native is the result of changes in hydrology and lack of appropriate management to remove non-native plants within the habitat of the Hine's Emerald Dragonfly. Changes in hydrology are the result of storm water runoff from the Route 53 and less water discharging from the groundwater fed seeps. Changes to the hydrology have been gradual and as a result the invasion and spread of non-native and aggressive species has been slow as well. During the last ten years, it has become apparent that non-native and low quality aggressive plant species provide poor habitat for the Hine's Emerald Dragonfly. The dragonfly seems to prefer native hummock forming sedges, rushes and grasses. Prior to this understanding, management efforts were not directed at controlling these problem species within the marsh and as a result these species have become dominant. In older invasion areas, Common reed and Cattails have out competed the native herbaceous species and provide suboptimal habitat. The mean conservatism value of this plant community is **1.81**. This indicates that this wetland community is highly degraded, dominated by non-native or weedy plant species and offers poor quality habitat for native wildlife species.

Sedge Meadow

The sedge meadow is similar to the marsh in that it is located in low lying areas within LPNP that hold water for much of the year and have been impacted in the same way from the changes to hydrology and invasion of non-native and aggressive native plant species (Common reed and Cattails). Sedge meadows are typified by their dominance of sedge species that form numerous hummocks. Hummock forming plant species are known to support and facilitate the establishment of a diversity of native wetland plant species. Characteristic hummock forming

species of sedge meadows are Tussock Sedge (*Carex stricta*) C value of 5 and Lake Sedge (*Carex lacustris*) C value of 6. The loss of hummocks has greatly reduced the structural diversity and species diversity of the sedge meadow areas within LPNP. The invasion of Common reed and Cattails has started to outcompete the lower stature native plant species, including hummock forming species. In some of the older areas of the Common reed and Cattail invasion, the sedge layer has been lost. The invasion by non-native and aggressive plant species has and will continue to degrade the structure and function of the sedge meadow. The mean conservatism value of this plant community is **3.82**. This indicates that this community still holds many conservative species but has started to undergo invasion by non-native plant species, which will over time out compete high quality native plant species.

Dolomite Prairie

All five hydric phases of dolomite prairie inhabit LPNP: wet, wet/mesic, mesic, dry/mesic, and dry. Wet and wet/mesic dolomite prairies are globally imperiled (Natureserve 2014). Dolomite prairies are characterized by shallow soil and the absence of woody plants, along with certain indicator species of grasses, sedges, and a few forbs. Tufted Hair Grass (*Deschampsia caespitosa* var. *glauca*) and Side Oats Gramma (*Bouteloua curtipendula*) typify the wet and dry hydric extremes, respectively. The inhabitancy of *D. caespitosa* var. *glauca* here suggests that minerotrophic groundwater is near the surface throughout the growing season and that surface water runoff has little or no influence within areas that are inhabited by *D. caespitosa* var. *glauca*.

The more frequent forbs are Mountain Mint (*Pycnanthemum virginianum*), Heath Aster (*Aster ericoides*), Nodding Onion (*Allium cernuum*), Round Fruited St. John's Wort (*Hypericum sphaerocarpum*), Riddell's Goldenrod (*Solidago riddellii*), and Swamp Thistle (*Cirsium muticum*). These species are fairly typical of calcareous prairies in the region, but the Round Fruited St. John's Wort is more routinely associated with carbonate-rich bedrock and Swamp Thistle associated with fens that are present in most circumstances where minerotrophic (refers to high amounts of dissolved minerals) groundwater is near the surface. There are several species that are regionally associated with these dolomite prairies and are uncommon within Illinois, which include: *Penstemon hirsutus*, *Dalea foliosa*, *Actinea herbacea*, *Muhlenbergia cuspidata*, and *Arenaria patula*.

Wet Dolomite Prairie

The wet prairie, which includes the globally rare wet dolomite prairie, is located in small discrete patches within LPNP. This community has also experienced invasion and establishment of non-native species, Common reed and Cattails. Wet prairies, although having wet and saturated soil most of the year, usually dry out during the hot summer months allowing them to sustain a few hearty mesic plant species in addition to wetland obligate species. The wet prairies in LPNP are still considered fair quality but have been declining over the past ten years. The mean conservatism value of this plant community is **3.00**. Because of the influx of invasive plant species and the influence of changes in groundwater discharge into site, the wet prairie has undergone a slow degradation resulting in loss of conservative species and an increase in non-native plant species.

Wet Mesic Prairie

For the purposes of this study patches within LPNP containing wet mesic dolomite prairie, successional field and wet mesic prairie were combined into one community called wet mesic

prairie. Wet mesic prairie occurs adjacent to the wet prairie and sedge meadow, occurring in areas that may be moist or wet in the spring, but usually drying out earlier in the year than the wet prairie and sedge meadow. Wet mesic prairies contain a mixture of wetland and mesic species, such as Ground nut (*Apios americana*) C value of 7 and Switchgrass (*Panicum virgatum*) C value of 5. The wet mesic prairie is in fairly good condition. A population of the federally listed Leafy Prairie Clover (*Dalea foliosa*) can be found within this community. The past invasion of European buckthorn (*Rhamnus cathartica*) is mostly under control as a result of regular prescribed fires. However, this area is under threat by the continued increase in Common reed and Cattails that has covered most of the marsh, sedge meadow and wet prairie. The current mean conservatism value of this plant community is **3.33**. Similar to other remnant plant communities within LPNP, the mean conservatism value of 3.33 indicates that the community is in fair condition with signs of degradation, namely the invasion of Common reed and Cattails.

Mesic Dolomite Prairie

Similar to the wet mesic prairie, the mesic dolomite prairie is in fair condition. The mesic dolomite prairie is less influenced by surface water runoff than the lower lying areas of LPNP. However, regular prescribed fires have not been able to fully control non-native and native aggressive woody species, such as Japanese honeysuckle (*Lonicera maackii*) and Gray dogwood (*Cornus racemosa*). These species can be resistant to all but the hottest fires. Increased shade of woody species has altered the amount of available light penetrating to the herbaceous layer. As a result, some of the more sensitive herbaceous species are decreasing in abundance (FPDWC personal communications). The current mean conservatism value of this plant community is **3.22**. This plant community is in fair condition with a number of conservative plant species as well as a number of non-native shrubs that has facilitated the establishment of other non-native herbaceous plant species.

Dry Mesic Prairie (Dry and dry mesic dolomite)

The dry and dry mesic dolomite prairie patches have been combined for the purposes of this study into the community called dry mesic prairie. The dry mesic prairie is in good condition within LPNP. Regular prescribed fires have greatly reduced the cover of non-desirable woody species and invasion of non-native and aggressive plant species have been small-scale and not yet a problem. The ability of this area to carry hotter fires is because of the location of this community within drier areas of LPNP and the dominance of native herbaceous species that provide optimal fuel for grassland fires. Hotter fires have kept the presence of woody species to a low level. The federally listed Lakside daisy (*Actinea herbacea*), C value of 10, inhabits this plant community in small patches that are characterized by exposed dolomite bedrock with a thin layer of organic material. The current mean conservatism value of this plant community is **3.52**. Similar to the mesic prairie, the dry mesic prairie is fair to good condition with some degradation due to the presence of non-native shrubs.

Floodplain Forest

The floodplain forest is located within LPNP adjacent the Des Plaines River. This plant community is vastly different from the herbaceous dominated prairie plant communities within LPNP. The flood waters from the Des Plaines River are much more influential within this community type. Flood waters bring in seed from non-native sources up stream. As a result there is a shrub layer that is dominated by non-native invasive species. Non-native floodplain shrubs include Glossy buckthorn (*Frangula alnus*), and Japanese honeysuckle (*Lonicera*

maackii). Non-native shrubs have almost eliminated the native herbaceous layer. Without a native shrub layer and a native herbaceous layer, the floodplain forest provides low quality habitat for a variety of resident and migratory wildlife species. A structurally and functionally homogeneous shrub and herbaceous layer provides very low diversity of resources for important species of native pollinators (native *Bombus spp.*) and migratory bird species (e.g., Ovenbird). The canopy layer contains common riparian tree species such as Eastern cottonwood (*Populus deltoides*) C value of 2 and Silver maple (*Acer saccharinum*) C value of 0. The current mean conservatism value of this plant community is **1.73**.

Oak Savanna

The current location of the Oak Savanna is along the steep slopes, referred to as the bluffs, which are adjacent to Route 53. The Oak Savanna is found within the narrow band of bluffs that run north south along the western boundary of LPNP. This is a degraded Bur Oak/White Oak savanna. This plant community type was commonly found along north and east facing dry slopes before settlement of the area. Oaks are generally fire resistant and able to withstand all but the hottest fires. This oak savanna has been invaded by non-native shrubs (European buckthorn and Japanese honeysuckle) and as a result has lost many native herbaceous species. Loss of the native herbaceous layer has reduced the suitability of this community for many native wildlife species. Common herbaceous plants of this Oak savanna include Timothy (*Phleum pratense*) C value of 0 and Kentucky bluegrass (*Poa pratensis*) C value of 0. The current mean conservatism value of this plant community is **1.33**.

Table 1. Baseline Conditions of Plant Communities

Plant Communities	Total Acres	Mean C
Ag/Old Field	623.7	0.42
Oak Savanna	15.2	1.33
Marsh	159.5	1.81
Sedge Meadow	9	3.82
Wet Prairie	30	3.00
Wet Mesic Prairie	29.4	3.33
Mesic Prairie	15	3.22
Dry Mesic Prairie	25	3.52
Floodplain Forest	20.7	1.73

Mean C – Mean Coefficient of Conservatism

2.3.2 – Wildlife

LPNP is a refuge for populations of several turtle species that include the State-threatened Blanding's Turtle (*Emydoidea blandingii*), which is also a candidate species for Federal listing. The prairie also supports the State-endangered Spotted Turtle (*Clemmys guttata*), which is at the westernmost limits of its range in Illinois (Wilson 1994). Populations of these and other turtle species are being studied intensely by Dave Mauger of the FPDWC and other researchers from the Illinois Natural History Survey.

Two state-listed snakes were observed within the nature preserve in the past, but have not been seen since 1994 and are probably extirpated from the site. They are the Ribbon Snake (*Thamnophis sauritis*) and the Kirtland's Snake (*Conophis kirtlandi*).

Another impressive element of LPNP is its rare ant fauna. No fewer than 21 ant species, about 20% of the Chicago region's ant fauna, have been identified. The assemblage of conservative ants at Lockport Prairie is quite dissimilar to any other yet recorded in the Chicago region. As with the plant communities at Lockport Prairie, the ant populations are closely associated with the subtle changes of groundwater hydrology. Ants such as *Formica montana*, *Formica glacialis*, *Acanthomyops claviger*, *Lasius umbratus*, and *Myrmica fractiformis* testify to the high water table in the mesic portions of LPNP, while *Lasius flavus*, *Lasius alienus*, and *Brachymyrmex debilis* nest only in the complexes of discharge zones. The drier prairie remnants include *Myrmicine* species such as *Aphaenogaster N16*, *Crematogaster cerasi*, *Monomorium minimum*, and *Solenopsis molesta*; the *Formicines*, *Formica incerta*, *Formica lasioides*, *Formica nitidiventris*, and *Formica rubicunda*; and the *Dolichoderine*, *Tapinoma sessile*. In the more mesic or wetter phases, the *Formicine* species, *Acanthomyops claviger*, *Formica glacialis*, *Formica montana*, and *Lasius umbratus* are present, each of which were found in mounds characteristic of their species; *Myrmicine* species here included only *Myrmica fracticornis*. The dolomite flagstones along the wet/mesic discharge zones shelter the nests of several species that include: *Brachymyrmex depilis*, *Crematogaster cerasi*, *Formica nitidiventris*, *Lasius alienus*, *Lasius flavus*, *Lasius neoniger* with *Ponera pennsylvanica*, and *Tapinoma sessile*. In a stage-5 cottonwood log, in a wet/mesic dolomite prairie plant community, a nest of *Aphaenogaster tennesseensis* was discovered. This particular species is normally associated with more openly timbered landscapes, particularly those with White Oak (*Quercus alba*) or Burr Oak (*Quercus velutina*).

Common bird species are Canada Goose, European Starlings, Morning Doves and House Sparrows within PBP. The Canada Goose and Morning doves are primarily attracted to the short vegetation of open agricultural fields. Less common species seen at PBP include: Red-tailed Hawk, American Robin and Common Grackle. Common bird species at LPNP include: Red-winged Blackbird, Chick-a-Dee, American Robin, Northern Cardinal and American Goldfinch. Less commonly seen birds include species that are considered of concern and are listed as either threatened or endangered in the state of Illinois: Northern Harrier, Common Moorehen, Sandhill Crane, Least Bittern, Black-crowned Night-heron, Osprey and King Rail.

Mammals are dominated by generalist species most often found in urban and industrial landscapes with fragmented habitat. Common species include Eastern Gray Squirrel, Fox Squirrel, Striped Skunk, Deer Mouse and Meadow Vole. Occasional species include White-tailed Deer, Least Shrew, Chipmunks and Muskrats.

The USACE has been in communication and coordination with the USFWS since the beginning of this feasibility study. Planning meetings were held that were attended by the USFWS, FPDWC, Openlands and Lockport Township Park District where the list of federally listed and state listed species were discussed and concerns about these species were addressed.

2.3.3 – Threatened & Endangered Species

Plant Species:

Dolomite prairies provide the habitat for a suite of rare and protected plant, insect, and reptile species. A federally endangered plant species located at LPNP is the Leafy Prairie Clover (*Dalea foliosa*). The Leafy Prairie Clover was thought extinct until it was discovered in 1974

at LPNP. Since then several other populations have been found in nearby prairies. The federally-threatened Lakeside Daisy (*Actinea herbacea*), a plant of the Dry Dolomite Prairie, was all but extirpated in the region by the 1970's, but it has been revived locally through its reintroduction into LPNP in the mid-1980's. It has generally thrived where planted and has reproduced and spread in the drier areas. The State-threatened Stiff Sandwort, (*Arenaria patula*) is also present at LPNP. It prefers locations where bedrock is at or near the surface. It can be quite abundant in those few spots that supply its needs. A more detailed account of the Lakeside Daisy and Leafy Prairie Clover was not provided because the populations of these two species are stable within LPNP and are located in areas that do not have a heavy invasion of non-native species.

Wildlife Species:

Lockport Prairie is rich in animal diversity compared to other sites in suburban locations. Documented animals include: 123 species of birds, 18 species of mammals, 19 species of reptiles, and 9 varieties of amphibians. Significant species that are not protected at the Federal or state level include wading birds such as rails, herons and egrets, and the Queen Snake (*Regina septemvittata*). Area-sensitive grassland birds currently do not nest at PBP.

Hine's Emerald Dragonfly

Status and Range

The Hine's Emerald Dragonfly is the most endangered dragonfly in the United States. The state of Illinois listed the species as endangered in 1991 (IL Administrative Code. 1992. IL list of Endangered and Threatened Fauna, 17 IL administrative Code 1010. 1992. IL Register 16(1):107). It was listed as endangered by the USFWS in 1995 (Federal Register, Vol. 60, No. 17, Rules and Regulations, 9.5267). The range of the species is restricted to small populations at a few sites in the Midwest. Populations are located in the following states: Illinois, Wisconsin, Michigan and Missouri and formerly in Ohio, Indiana and Alabama. Habitat destruction and diminished habitat quality are prominent reasons for the rareness of this species. The specific type of wetland needed throughout the life cycle of this species is rare and through the conversion of this wetland type to agricultural, industrial and urban uses made even rarer.

Life History

The larval stage requires habitat within low flow wetlands with a period of drying in the summer season. Known Hine's emerald dragonfly larval sites include shallow, organic soils (histosols, or with organic surface horizon) overlying calcareous substrate (predominantly dolomite and limestone bedrock), calcareous water from intermittent seeps and springs, shallow small channels and/or sheetflow (Cashatt and Vogt 2001). The wetlands are fed by groundwater discharge and often dry out for a few weeks during the summer months, but otherwise have thermal regimes that are relatively moderate and are comparatively warmer in winter and cooler in summer than nearby wetland sites without groundwater influence. Larvae have been sampled from dry streamlet channels, which indicate a physiological adaptation to drought conditions (Soluk, et al., 1998). Some sites do include trees and shrubs scattered throughout the habitat. Emergent herbaceous and woody vegetation is essential for emergence of larvae (Soluk et al. 2002, Foster and Soluk 2004). All known sites have forested areas and/or scattered shrubs within a close proximity (Cashatt and Vogt 2001). Larva can

spend up to 4 years in the wetland before emerging as an adult. Throughout its life cycle the species is a predator and will feed on the larval forms of other insects. Larvae exhibit non-random distribution patterns in the wetlands and are found in clusters or widely separate individuals, which can make it hard to sample the population correctly (Soluk, et al. 2004). Larvae are most active at night and are less active during the daylight hours and during periods of cooler water temperatures (fall and early winter) (FWS 2001). Sites also include crayfish burrows, which the larvae can crawl into. These burrows are an integral life requisite for the species because they are essential for overwintering and drought survival (Soluk et al. 2004, Pintor and Soluk 2006).

The larval form of Hine's Emerald Dragonfly (Odonata: Corduliidae) is very similar to other species within the genus *Somatochlora* of North America. There are a few minor morphological differences, identified from a series of final instars and exuviae, which can be used in combination to differentiate Hine's Emerald Dragonfly. There are no apparent differences between the Wisconsin and Illinois populations in terms of differentiating characteristics (Cashatt and Vogt 2001). The following descriptions are further evaluated in Cashatt and Vogt 2001 and Federal Register 2006. The female and male final instars have middorsal hooks on segments 3-9 or 4-9 and the fourth hook well developed. Also, Hine's Emerald Dragonfly usually have 8-12 palpal crenulation setae, metatibia length-to-head width ratio less than 1.25 and comparatively low lying middorsal hooks. Final male instar larvae can be readily identified by the unique terminal appendage, bent downward at a right angle near the tip (segment 10).

The adult habitat includes the wetland systems as well as a mosaic of upland plant communities and corridors that connect them. Areas of open vegetation serve as places to forage. Foraging flights for reproductive adults may be 1-2 km (0.6-1.2 mi) from breeding sites, and may last 15 to 30 minutes. Forest edges, trees, and shrubs provide protected, shaded areas for the dragonflies to perch. Limited information is available on the species' dispersal capabilities. The average distance traveled by dispersing adults was documented to be 2.5 miles in a study in Illinois (Mierzwa et al. 1995 and Cashatt and Vogt 1996). Hine's Emerald Dragonfly generally does not travel more than 328 feet (ft) from the edge of a forested track into the interior. Foraging occurs with the herbaceous wetland areas and in some cases, such as Missouri, adjacent old fields and pastures. Adult Hine's emerald dragonflies require a sufficient prey base of small flying insects (Vogt and Cashatt 1994, Zuehls 2003). Adult Hine's emerald dragonflies feed on the wing, sometimes in swarms, primarily mid-morning to midday and late evening (Zuehls 2003). Foraging behavior is the dominant behavior within swarms, with over 99 percent of dragonflies observed within swarms foraging and swarms are generally found within ½ mile to 1 mile of breeding sites (Zuehls 2003). Adults will use nearly any natural habitat for foraging near the breeding/larval habitat except open water ponds and closed-canopy forested areas. Preferred foraging habitat consists of various plant communities including marsh, sedge meadow, dolomite prairie, and the fringe of bordering shrubby and forested areas. The young adults emerge in late spring, mate, and lay eggs in water. The eggs overwinter. After hatching the larvae prey upon aquatic invertebrates, occupy rivulets and seepage areas, and take refuge in crayfish burrows. The larvae live 2 to 5 years before adult emergence takes place (Soluk 2005, Soluk and Satyshur 2005). Adults live for only a few weeks.

The adult Hine's Emerald Dragonfly has brilliant green eyes. It is distinguished from all other species of *Somatochlora* by its dark metallic green thorax with two distinct creamy-yellow lateral lines, and distinctively-shaped male terminal appendages and female ovipositor

(Williamson 1931). Adults have a body length of 60-65 mm (2.3-2.5 in) and a wingspan of 90-95 mm (3.5-3.7 in).

The federally endangered Hine's Emerald Dragonfly is endangered in part because of the very narrow range of environmental conditions it requires to survive. The most important component of the complex relationship between aquatic organisms and their habitat is hydrology. The Hine's Emerald Dragonfly has a specialized niche, consisting within in a narrow range of hydrologic conditions. Those requirements include high quality groundwater from seeps, which forms slow moving rivulets that dry up for a few weeks a year. The amount of groundwater must be enough to keep sediments from filling in the channels but not enough to increase the flow that will destabilize the larvae and cause drift. The ability to withstand a period of dry down is theorized as a mechanism to avoid other dragonfly species that would not be able to withstand the dry down and results in decreased competition for resources within the rivulets.

Beyond the significance of hydrology, the other plant and animal species occupying the streamlet are also important. Hine's Emerald Dragonfly occupies rivulets meandering through native grass and sedge communities. Larvae have not been found in similar rivulets flowing through non-native stands of vegetation. Also, the larvae utilize crayfish burrows during periods of decreased water flow as refuge and overwintering. The burrows have been found to provide significant protection for the larvae. A specific species of crayfish (*Cambarus diogenes*) are the builders of these burrows. Hine's Emerald Dragonfly has not been found without *Cambarus diogenes* burrows present within the area.

Population Status and Threats Assessment

Lockport Prairie Hine's Emerald Dragonfly population and status

This site contains one of the largest breeding populations in the state of Illinois. Information gathered from population monitoring has indicated a decline in reproductive rates of some of the rivulets. Larvae densities have decreased from approximately 6-8 larva per/m² to 1-2 larva/m² over the last 5-10 years (Soluk, personal communication). This was attributed to a shift in the hydroperiod of the groundwater entering into the site, which feeds into the rivulets. The shift can be described as less water entering the rivulets and wetland areas at critical periods during the growing season and the habitat drying out earlier in the year. Other threats to the population and habitat include: encroachment of invasive and woody species, management and land use maintenance of utility and road right of way, and groundwater depletion, alteration, and contamination. The long-term viability of the population at Lockport Prairie is under question.

Illinois sites and status

There are nine confirmed sites with Hine's Emerald Dragonfly populations, with potentially more to be confirmed, although, not all of the sites have breeding populations. These sites are located in the following counties: Cook, DuPage, and Will. The sites in Will County have the greatest number of breeding adults and the highest reproductive success. All of these sites are imperiled through a variety of natural and human threats. Threats to the last remaining populations include: ecological succession and encroachment of invasive species, illegal all-terrain vehicles, utility and road construction and maintenance, management and land use maintenance of utility and road right of way, and groundwater depletion, alteration, and contamination.

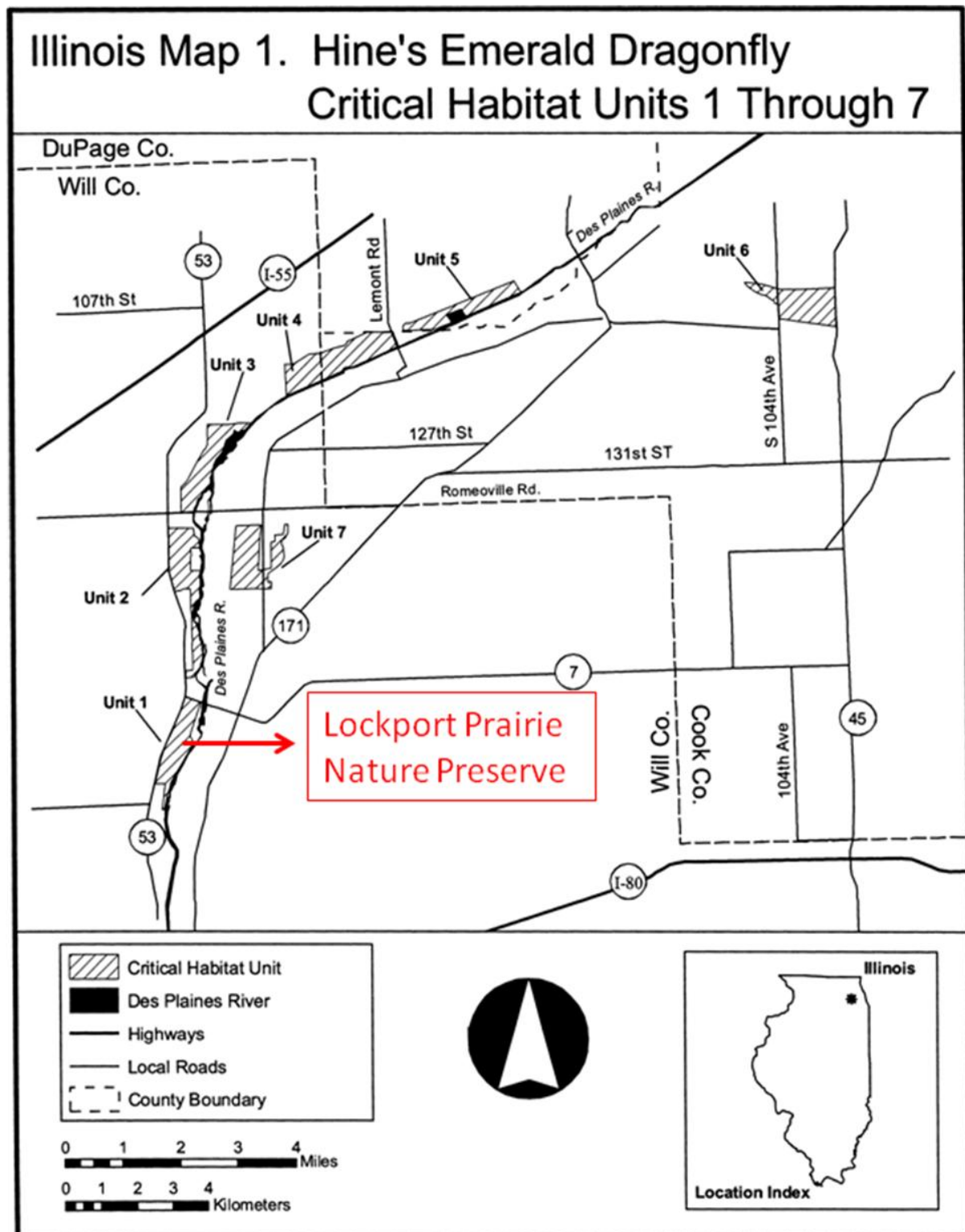


Figure 7. Location of Hine's Emerald Dragonfly Critical Habitat in Illinois.*

**The footprint of the project site is within in the Critical Habitat within LPBP.*

Table 2. List of Wildlife Species of Concern from Study Area

E = Endangered, T = Threatened.

Scientific Name	Common Name	Type	IL Status	Federal Status
<i>Circus cyaneus</i>	Northern Harrier	Bird	E	
<i>Clemmys guttata</i>	Spotted turtle	Reptile	E	
<i>Clonophis kirtlandi</i>	Kirtland's snake	Reptile	T	
<i>Emydoidea blandingii</i>	Blanding's turtle	Reptile	T	
<i>Gallinula chloropus</i>	Common Moorhen	Bird	T	
<i>Grus canadensis</i>	Sandhill Crane	Bird	T	
<i>Ixobrychus exilis</i>	Least Bittern	Bird	T	
<i>Nycticorax nycticorax</i>	Black-Crowned Night-Heron	Bird	E	
<i>Pandion haliaetus</i>	Osprey	Bird	E	
<i>Rallus elegans</i>	King Rail	Bird	E	
<i>Somatochlora hineana</i>	Hine's Emerald Dragonfly	Insect	E	E
<i>Thamnophis sauritus</i>	Eastern Ribbon snake	Reptile	T	

2.4 – Cultural Resources

2.4.1 – Cultural & Social Properties

The Lockport Prairie area, which includes Prairie Bluff Preserve, of the Forest Preserve District of Will County is an important area for public recreation because of the presence of many endangered species and rare plant communities. Available facilities include as designated areas for hiking, cross-country skiing, picnicking, and fishing.

2.4.2 – Archaeological & Historical Properties

Lockport Prairie:

Historic Land Use - Portions of the project area have been disturbed by construction of roads (Division Street); by installation of railroad lines (sometime between 1932 and 1954, probably after 1942); by dumping and earthmoving; and by quarrying of near-surface limestone during the late nineteenth century.

Prehistoric Site - The Lockport Prairie project area lies in the floodplain and floodway of the Des Plaines River. The preserve contains low gravel ridges; however, much of it is low, wet (hydric soils), covered in wetland vegetation, and would not have been attractive as an aboriginal occupation site.

Division Street (16th Street) Bridge - The only standing structure immediately adjacent to the project area is a three-span steel-truss bridge with masonry abutments at the east end of Division Street (spanning the Des Plaines River, west of the San-Ship Canal). The bridge is just over 500' long (with two truss designs), and was built by the Chicago Sanitary District in the 1890s; it is owned by the MWRD, and is probably eligible for listing on the National Register of Historic Places. The bridge is listed on Will County's register of historic places.

I&M Canal and Heritage Corridor - Adjacent to the Illinois Waterway, the Illinois and Michigan Canal (built 1836-1848) is a National Historic Landmark, listed on the National Register of Historic Places; the canal area was designated the Illinois and Michigan Canal Heritage Corridor in 1984. The Lockport Prairie project area lies within the heritage corridor.

Chicago Sanitary and Ship Canal - The CSSC or "San-Ship" was built by the Chicago Sanitary District (now the MWRD) in 1892-1900, by predominantly Polish laborers from Chicago. The San-Ship was built parallel and adjacent to the older Illinois & Michigan Canal (built 1836-1848); the new channel secured the reversal of the Chicago River (carrying Chicago's sewage away from its Lake Michigan water supply), and became part of the Illinois Waterway after 1933. The Corps and the Illinois Historic Preservation Agency found the CSSC eligible for listing to the National Register to Historic Places in January 2003; the CSSC is historically significant (under criteria A and C of 36 CFR Part 60) as a landmark in wastewater control and treatment, and one of the largest public works. The Lockport Prairie project area lies adjacent to the San-Ship Canal.

San-Ship Canal Historic District - The CSSC Historic District consists of three structures (Main Channel, Willow Springs Spillway, and Lockport Controlling Works), one site (Butterfly Dam Remnant) and one district (Lockport Lock, Dam, and Power House Historic District). The Main Channel has seven contributing features, consisting of the cut natural walls, laid-up stone walls, stone bridge abutments, commemorative tablet, original spoil piles, main channel extension, and original earthen walls. The Lockport Lock, Dam, and Power House Historic District has five contributing structures, consisting of the Sanitary District Lock, New Lock, Dam, Power House, and the Control Station. The Lockport Prairie project area lies about ¼ miles north of the historic district.

Illinois Waterway - The Illinois Waterway system (IWW) was initiated when Congress passed the River and Harbor Act of 1927 that authorized funds for its improvement from Utica, Illinois to St. Louis, Missouri; that legislation was modified in 1930 to include the State of Illinois project from Utica to Lockport. The IWW extends from the mouth of the Chicago River on Lake Michigan (via the CSSC, Des Plaines River, and Illinois River) to the Mississippi River at Grafton, Illinois. In July 1993, the Illinois Historic Preservation Agency and the Rock Island District Corps of Engineers determined that portions of the IWW Navigation Channel, from mile 80.2 to 327.0, were eligible for listing on the National Register of Historic Places. A final NRHP Nomination Registration Form was accepted by the Illinois Historic Preservation Agency in January 2002. Significant portions of the IWW are designated the "Historic Resources of the Illinois Waterway Navigation System, 1808-1951"; nomination forms have been submitted to the National Park Service for evaluation and listing. The Lockport Prairie project area lies adjacent to the Illinois Waterway.

Prairie Bluff Preserve:

The Prairie Bluff Preserve is an agricultural field between Rt. 53 and Weber Road, north of Division Street and the state penitentiary; the parcel covers about 1000 acres; it contains no structures.

Lockport, 1830-1980:

Present Lockport was the west end of the "Yankee Settlement" of 1829-1835; squatter Holder Sisson had a blockhouse here during 1832 Black Hawk War, and Butterfield's ford crossed the Des Plaines River here; this location was Runyon's Town (possibly part of the Yankee Settlement) in 1830. Lockport was platted by canal commissioners in 1837; State Street contains many mid- to late-19th-century commercial buildings. National Register properties include the Lockport Historic District (37 sites and structures); the town lies within the I&M Canal National Heritage Corridor. In the 1840s, Lockport had blacksmiths, shoemakers, tanners, harness makers, flour mill, coopers, distillery, sawmill, and lime kiln. Sawmills were in operation in the 1830s at Lockport, before completion of the I&M Canal. After the canal opened, all of the corridor's sawmills closed except for Norton's sawmill at Lockport; Norton's lumber mill was converted to a paper mill in 1872. Daggett's grist mill at Lockport opened in 1838; in 1850 the sole mill in Lockport was that of Hiram Norton. By 1870 Norton's was the largest flour mill in Illinois; it closed in 1907.

Lockport had important limestone quarries after the early 1850s. Quarrying for building stone ended around 1900; as demand for crushed rock decreased, many quarries closed, and by 1925 only one operated at Lockport. Material Service Corporation at Lockport still makes crushed limestone.

Texaco built refineries at Lockport in 1911 (these became tank farms in 1981 and closed in 1997 or 1998). The 1929 Depression closed many plants in the Des Plaines River corridor. Surviving firms included Texaco, Material Service (quarries), and Northern Illinois Cereal in Lockport; after WWII, heavy industry in the corridor was gradually replaced by oil refineries and petrochemical companies.

Joliet, 1830-1980:

Joliet was platted 1834 as "Juliet", incorporated 1852 as "Joliet". Two dams on the I&M Canal at Joliet provided hydropower for machine shops and a small flour mill. In the 1890s electric companies generated power with canal water at Joliet. National Register properties include the East Side Historic District; Old State Penitentiary (1856); and Joliet Heritage Park (steel-mill ruins of 1869-1950s). Notable historic buildings remain in downtown Joliet, but their setting has been marred by widespread demolition. The town lies within the I&M Canal National Heritage Corridor.

Sawmills were in operation in the 1830s at Lockport and Joliet, before completion of the I&M Canal. Joliet (which grew faster than the other canal towns), attracted large factories making shingles, wool cloth, beer, stoves, and wagons. Meat packing plants opened in Joliet in the 1850s (accompanied by factories making glue, soap, and candles) but had closed by 1870, probably due to the greater efficiency of the centralized Chicago stockyards. Flour mills were operated in Joliet at the same time, but none competed with Norton's mill at Lockport.

Steel mills opened in Joliet in 1869, producing nails, plate, wire, and rails. Joliet was eighth in the U.S. in the production of iron and steel during 1900-1920. Joliet manufacturing firms in 1920 included steel mills, wire and nail factories, railroad shops, brickworks, chemical companies, and wallpaper companies.

Joliet had important limestone quarries after the early 1850s. Quarrying for building stone ended around 1900; demand for crushed rock decreased, and many quarries closed; by 1925 only two operated at Joliet. The 1929 Depression closed many plants in the Des Plaines River corridor. Surviving firms included steel mills and chemical companies in Joliet; after WWII, heavy industry in the corridor was gradually replaced by oil refineries and petrochemical companies.

2.4.3 – Land Use History

Located within the Des Plaines River Valley, Lockport Prairie was once a part of the drainage pathway of the ancient Glacial Lake Chicago during the Pleistocene Age. Around 12,000 years ago the glaciers retreated and large volumes of water flowed through this pathway eroding it to down to the bedrock. The thin layer of organic soil and almost permanent wet conditions, because of the closeness of the groundwater table, made the prairie unsuitable for farming. It was purchased by the Chicago Sanitary District (now Metropolitan Water Reclamation District of Greater Chicago, MWRD) as part of the construction of the Chicago Sanitary and Ship Canal in the 1890s. Prior to their purchase some mining of limestone and dolomite was attempted in the drier areas of the site. Division Street, the east/west oriented road that bisects (between MU3 and MU4) the site, was built in the 1890's and the north/south oriented Chicago and Western Rail Road (between MU2 and MU3) was built sometime between 1932 and 1954 to move coal to coal-fired power plants in the Chicago region. Division Street is no longer an active roadway, but serves as access to the site for the Forest Preserve District of Will County. The Division Street Bridge over the Des Plaines River is only accessible by foot. The Chicago and Western Rail Road is still active. In the surrounding areas, agriculture remained the principal occupation until the 1940s. Since the 1950's the region has experienced a steady increase in population as the communities surrounding the Lockport have developed into residential areas for people working in metropolitan Chicago.

Lockport Prairie was owned by MWRD from the 1890's to 2011. Lockport Prairie was dedicated as an Illinois Nature Preserve in 1983. The Forest Preserve District of Will County has leased and managed the property since the 1970's prior to purchasing the property in 2011.

Prior to Euro-American settlement Prairie Bluff Preserve was primarily covered by a mosaic of marsh, sedge meadow and Tallgrass prairie. After settlement in the early 1800's this area was cleared and was used as pasture in the drier areas. It is believed that the site was then drained in the early 1900's through the installation of drainage tiles. The site was then put into agricultural commodity production after installation of drainage tile. Commodities have been primarily corn and soybean for the last 50 years.

Prairie Bluff Preserve and much its surrounding properties have been owned by the State of Illinois since the 1970s. The land has been leased and managed by the Forest Preserve District of Will County since 2007. Most of the land continues to be in agriculture production. In 2009-10, a paved road was installed leading to a parking and picnic area within the northwest corner of the site. A large reason that this agreement was put into place was the result of the

hydrological studies that indicated this area is an important part of the recharge zone of the groundwater that discharges into Lockport Prairie.

2.4.4 – Social Properties

Demographics

Lockport - the city's population in 2000 was 15,191; the population was almost 94% white, about 1% African American, about 1% Asian, and about 4% Hispanic; median household income in 1999 was \$59,179; median home value was \$149,700; about 3% of Lockport's people lived below the poverty level. Home ownership rate was about 79%.

Lockport Township - The township's population in 2000 was 42,048; of that number about 82% were white, about 11% African American, about 1% Asian, and about 9% Hispanic. Home ownership rate was about 78%; median household income in 2000 was \$51,242; median home value was \$128,700; about 3% of the township's people lived below poverty level.

Joliet - the city's population in 2000 was 106,221; estimated 2003 population was 123,570. In 2000 Joliet's population was just over 67% white, just over 16% African American, just over 1% Asian, and over 15% Hispanic. Almost 11% of Joliet's people lived below poverty level. Home ownership rate was about 70%. In 2000 the median home value was \$119,900; in 1999 median household income was \$47,761.

Will County - the county's population in 2000 was 502,266; estimated 2005 population was 642,813. In 2004 Will County's population was almost 78% white, almost 9% African American, just over 3% Asian, and almost 10% Hispanic. In 2000 median home value for the county was \$154,300; home ownership rate was 83%. In 2003 the median household income was \$63,475. Almost 7% of the county's people lived below poverty level.

Recreation

The Lockport Prairie Nature Preserve is used by hikers and birdwatchers.

2.5 – Habitat Quality Forecasting

2.5.1 – Habitat Assessment Methodology

Currently, the project site (LPNP and PBP) are managed in units (MU1 through MU4). Management units represent areas of the project site that contain similar plant community types and have similar ecological problems. The habitat assessment was conducted using the management units as a way to organize information about habitat conditions across the project site. Management units are described below and mapped in Figure 8:

Management Unit 1 - Prairie Bluff Preserve

The 623.7-acre Prairie Bluff Preserve (PBP) site is immediately west of LPNP, along Route 53. PBP is bordered by a residential subdivision to the west, Division Street to the south, Route

53 to the east and Renwick Road and the Prairie Bluff Golf Course to the north. The property is located in the northwest 1/4 of Section 27 and the central portion of Section 22, T36N, R10E. PBP provides a critically needed area of groundwater recharge for the Hine's Emerald Dragonfly. Currently, the property is leased for farming, which does little to enhance the groundwater recharge potential of the site.

Management Unit 2 – LPNP Bluff North

The 19.7-acre unit is within the LPNP between the railroad tracks and Route 53 and north of Division Street. It encompasses a small sliver of land recently purchased from MWRD for management of invasive species and erosion along the bluffs. The area is situated in the SW quarter of section 22, township 36 North and range 10 East. The unit is bordered by Route 53 to the west, the railroad tracks to the east, Division Street to the south and Renwick Road to the north.

Management Unit 3 – LPNP North

The 142.6-acre prairie north unit is the part of the original LPNP. The unit is situated in the center of section 22, township 36 North and range 10 East. The unit is located north of Division Street, south of Renwick Road, west of Des Plaines River and east of the railroad tracks. Threatened and endangered species occupy this and the prairie south unit.

Management Unit 4 – LPNP South

The southern portion of LPNP is 141.5-acres and is located in the NW quarter of section 27 and a small part in the SE quarter of section 28, township 36 North and range 10 East. The southern boundary is bordered by a forested area approximately 0.4 miles south of Division Street, with Division Street bordering the north, Des Plaines River bordering the east and Route 53 along the western border.

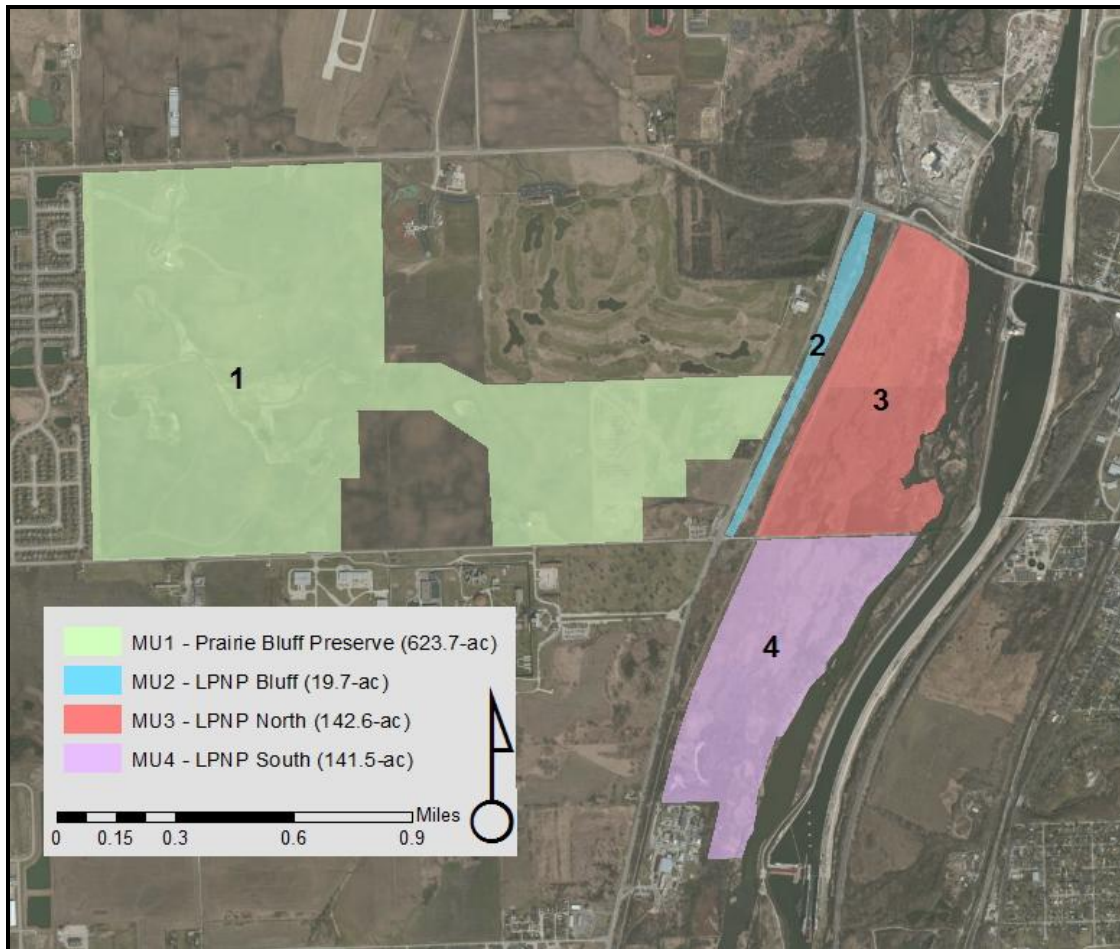


Figure 8. Location of Management Units

Many methods are available to measure current ecosystem resource conditions and to predict future conditions of those resources. Habitat assessment methods developed for individual species may have limitations when used to assess ecosystem restoration problems and objectives. They do not consider communities of organisms and typically consider habitat in isolation from its ecosystem context. The assessment methodology selected for this study is community based and was chosen by how well the technique meets the needs of the study goals, objectives, and level of detail. The assessment methodology, or Floristic Quality Assessment (FQA), focuses on composition and function of the plant community. This was chosen to assess the ecological value of the proposed future without-project condition and any ecosystem level changes that result from the proposed management measures for LPNP. There was no weighting per community type since each part of the ecosystem is just as important as the other. The FQA is a regionally approved model for USACE planning use.

Floristic Quality Assessment

The determination of “quality” with respect to plant assemblages has been the subject of much research and development since the mid 1970’s. Quality, as used in this study, is essentially an assessment of the degree to which native plant species are present within defined plant communities. Plants are exceptional indicators of short and long term disturbance in terms of habitat function and structure. Vegetation influences most aquatic functions such as net annual primary productivity. Plants are the largest primary producers in most systems, which make

them the primary vector of energy flow through an ecosystem. In addition, research has shown there to be strong correlations between vegetation and water chemistry. Most importantly for restoration, vegetation provides resources and habitat for entire suites of species, that than indirectly influence the entire food web of an ecosystem (e.g., insects, fish, birds, mammals, etc.). Out of the approximate 2,500 plant species known to occur in the Chicago Region, around one-third was not present before European colonization. Non-native species did not evolve within the same environmental conditions as the native species, and their persistence indicates a certain degree of functional disablement. Numerically describing the quality of an area using vegetation reflects the level of disturbance to the biological integrity of the site. In the Chicago Region, there is one commonly used approach that attempts to describe plant community quality with a simple numerical metric, which is the FQA (Swink and Wilhelm 1979). This assessment tool was designed to be used as an all-inclusive method, not just as a way to identify high quality sites. The FQA was originally developed for the Chicago Region, but has since been developed for regions and states throughout North America. This method has been extensively studied and shows great promise as a quick and easily understood method of assessing the quality of plant communities.

The FQA method specifically excludes the use of “indicator” species, instead assessing the sensitivity of all individual plant species that inhabit an area. Species “conservatism” is used as its basis for assessment; conservatism being defined as a level of tolerance each plant species exhibits to disturbance type, amplitude, and frequency, as well as fidelity to specific habitat types. As an area’s equilibrium is disturbed, the habitat’s capacity to absorb disturbance is weakened and the first plants lost will come from the high end of the conservatism spectrum. Therefore, what is being measured is the extent to which an area supports conservative native plants.

Based on species inventory, the FQA generates two essential metrics for an area inventoried: the Mean C, which is the average coefficient of conservatism, and the FQI, which is derived by multiplying Mean C by the square root of the number of native species inventoried,

$$FQI = \bar{C}\sqrt{N}$$

where C is the coefficient of conservatism and N is the number of species. The FQI, therefore, is a function of both conservatism (function) and species richness (structure). Typically, larger sites have a greater number of habitat types and likely will have greater species richness. Generally, both Mean C and FQI values are considered in the evaluation of an area or landscape unit. Based on statistical analysis of previous studies, the FQI shows a significant positive relationship to species richness (Ervin et al. 2006) and as such the Mean C value represents the more comparable and accurate metric.

Each native species has been assigned a coefficient of conservatism (C), ranging from 0 to 10. C values were assigned to species within a predefined geographic area by Swink and Wilhelm (1979). A 0 is assigned to species that are highly tolerant to human disturbance and are considered general in their habitat distribution and a 10 is assigned to species with a very low tolerance to human activities which display very specific relationships to certain habitat types. The following descriptions of categories were used to assign coefficients of conservatism to all plant species within the Chicago Region:

- 0-3 Wide range of ecological tolerance and found in a variety of conditions
- 4-6 Mid range of ecological tolerance and a smaller variety of conditions

- 7-8 Low range of ecological tolerance and associated with specific environmental conditions
- 9-10 Very low range of ecological tolerance and a narrow ecological niche

It has been demonstrated that sites with Mean C and Floristic Quality Index (FQI) values less than 2.8 and 20 respectfully, as surveyed during the growing season, are degraded or derelict plant communities. Sites with mean C values that approach 3.2 are considered to be moderately disturbed. When site inventories yield mean C values greater than 3.4 or higher, one can be confident that there is sufficient native character present for the area to be at least regionally noteworthy - such landscapes are essentially irreplaceable in terms of their unique composition of remnant biodiversity. Sites with mean C and FQI values greater than 4.0 and 50, respectively, are rare and indicate highly significant natural areas of statewide importance. For the purposes of this study, the Mean C was chosen as the formula to calculate environmental benefits that are predicted from the proposed restoration measures. The formula for the Mean C is as follows:

$$MeanC = \frac{\sum_{i=1} C_i}{I}$$

C – coefficient of conservatism

i – individual species

I – total number of species

With an active land management plan and time, the mean C and FQI values will reflect the extent to which conservative species are being recruited and the floristic quality is improving. In this way, the FQA method can be used to assess restoration management decisions, as well as to document floristic changes (positive or negative) in the landscape over time. In addition, the FQA has been shown to be highly correlated with other biological assemblages in their response to disturbance and restoration actions. For example, Shuey et al. (2012) found that the FQA predicted the response of moth species to amount of degradation across a gradient of human disturbance within prairie ecosystems. Their results show the same pattern as a variety of other research projects on other insects groups such as Hemiptera and Lepidoptera (Grabas et al. 2012, Panzer and Schwartz 1998, Panzer et al. 2010 and Wallner et al. 2013). Finally, the FQA is also correlated with physical and chemical characteristics of lakes (Radomski and Perlberg 2012), as well as, fish assemblages in lake systems (Garrison et al. 2008). The FQA is a reliable indicator of other aspects of ecosystem function and structure.

Habitat Suitability Index

Habitat outputs for the future without and future with project condition were estimated over the entire 50 year period of analysis. In order to restore the ecosystem within the study area, both ecosystem function and structure were addressed through the FQA method described above. These predicted benefits are projected based on how the plant community will respond per the proposed restoration measures described in Section 3.1. In order to calculate the unit of measure for ecosystem benefits, which is Habitat Units, the Mean C score is divided by 10. This converts to score to a range of 0 to 10. The following formula was used to calculate HSI:

$$HSI = MeanC \div 10$$

Total habitat outputs, in terms of habitat units (HUs) were calculated by multiplying the affected area times the habitat suitability index:

$$HUs = A(HSI)$$

where A is the affected habitat area expressed in acres.

2.5.2 – Future Without-Project Conditions (FWOP)

In general, the project area is expected to continue to experience drier than normal conditions. This will negatively influence the suitability of breeding habitat for the Hine's Emerald Dragonfly and for much of the wetland dependent plants (e.g., Marsh speedwell) and animals (e.g., Blanding's turtle). Invasive plants species are expected to increase in coverage and abundance, forming an impenetrable layer blocking light and out competing many disturbance intolerant conservative plant species. The quality of the plant communities is expected to decrease through the loss of wetland dependent and conservative plant species. As the plant community degrades over time, many native animal species will no longer find Lockport Prairie a suitable site for breeding, foraging or resting.

In addition to be drier than normal, PBP will continue to offer low quality, non-native dominated plant communities as a result of current and past agricultural activities. Although some native animal species (e.g., White-tailed deer, Raccoon, Field mice, etc.) utilize this part of the project area, these species are generalists and are common throughout the Midwest and are not in need of additional habitat restoration. However, native species of concern that would have used this area in the past, such as grassland breeding birds (e.g., Henslow's sparrow and Dickcissel), will continue to be absent from PBP.

Agricultural /Old Field

The current low quality plant community within PBP would continue to remain dominated by non-native agricultural weeds. Even if drainage tile were to be disabled and wetlands able to reform on site, the probability of conservative plant species colonizing unassisted within these new areas is remote. Based on the fact that wetlands are unlikely to reform under current conditions and the ability of conservative plant species to colonize PBP unassisted, the Mean C of this plant community is expected to remain at **0.42**.

Oak Savanna

The current degraded condition of the oak savanna is not expected to recover unassisted. The presence of non-native shrubs will continue to shade the understory, limiting the ability of herbaceous plant species to persist. The inability of the herbaceous layer to reestablish will allow bare soil to remain a problem within the oak savanna. Bare soil in areas that receive runoff will continue to erode. Based on the continuation of the current problems and low probability of recovery without assistance, the Mean C of this plant community will remain at **1.33**.

Marsh

The marsh will continue to degrade over time because of the alteration in hydrology and invasive plant species. Sensitive wetland dependent species will find the marsh habitat within Lockport Prairie to be unsuitable as the site continues to experience drier conditions because of the alteration to the groundwater discharge. Wetland dependent species will be lost over time as drier conditions persist. In addition to drier conditions, invasive species (e.g., Cattails) are expected to increase in coverage and abundance. Invasive species will out compete disturbance intolerant native species (e.g., conservative plant species). The marsh community is expected to slowly degrade overtime resulting in a Mean C value of **1.27** in the future.

Sedge Meadow

Similar to the marsh community, the sedge meadow has and will continue to be impacted by altered hydrology and spread of invasive plant species. Drier conditions and increased coverage and abundance of invasive species will result in the loss of wetland dependent and sensitive conservative plant species. The Mean C value of the sedge meadow is expected to decrease to **3.31** over time.

Wet Prairie

Also similar to the marsh and sedge meadow, the wet prairie is expected to degrade over time. Degradation will occur from continued altered hydrology (e.g., generally drier conditions) and increased invasive species abundance and coverage. Drier conditions and increased influence of invasive plant species will result in the loss of wetland dependent and sensitive conservative plant species. As the wet prairie plant community loses high quality species, the Mean C value of this plant community will decrease to **2.4** in the future.

Wet Mesic Prairie

Although the wet mesic prairie is influenced by discharging groundwater from the surrounding bluffs, the majority plant species within this community are not wetland dependent, and as such this community is not expected to experience degradation through continued altered groundwater discharge. However, the current level of degradation, through the impact of non-native shrubs, is expected to continue. This plant community is expected to maintain the Mean C value of **3.33**.

Mesic Prairie

This community has been impacted by the invasion of non-native shrubs that alter the amount of light and available below-ground physical space (e.g., root structure) for native high quality herbaceous plant species. Prescription burns performed by the Forest Preserve District of Will County help to knock back the above-ground portion of these shrubs, but is not enough to completely remove them. Non-native shrubs are expected to persist over time. This community is not expected to recover unassisted, therefore the Mean C value is expected to remain at **3.22** for this plant community.

Dry Mesic Prairie

Similar to the mesic prairie, the dry mesic prairies is expected to remain stable, although moderately disturbed, over time. Non-native shrubs are expected to remain a degrading force.

This plant community is expected to maintain the Mean C value of **3.52** under future without-project conditions.

Floodplain Forest

The floodplain forest has and will continue to be impacted by the presence of invasive plant species and low number of native plant species. The continued coverage of invasive plant species will eventually out compete some of the more sensitive plant species that remain within this community. Competition from both non-native shrubs and herbaceous invasive species will continue to alter the suitability of this community for native plant species that may emigrate from other floodplain areas upstream of the site, decreasing the probability that the native plant community could recover unassisted. Without the removal of invasive plant species, this community will continue to degrade resulting in a Mean C value of **1.5**.

Table 3. Future Without-Project (FWOP) Conditions

Plant Communities	Acres	Current Mean C	FWOP Mean C	FWOP AA Mean C	FWOP HSI	FWOP HU
MU1						
Ag/Old Field	623.7	0.42	0.42	0.42	0.042	26.2
Total MU1 Acres	623.7					
MU2						
Oak Savanna	15.2	1.33	1.33	1.33	0.133	2.02
Marsh	4.5	1.81	1.27	1.48	0.148	0.67
Total MU2 Acres	19.7					
MU3						
Marsh	80	1.81	1.27	1.48	0.148	11.84
Sedge Meadow	5	3.82	3.31	3.6	0.36	1.80
Wet Prairie	10	3.00	2.40	2.7	0.27	2.70
Wet Mesic Prairie	15.6	3.33	3.33	3.33	0.333	5.19
Mesic Prairie	7	3.22	3.22	3.22	0.322	2.25
Dry Mesic Prairie	15	3.52	3.52	3.52	0.352	5.28
Floodplain Forest	10	1.73	1.50	1.54	0.154	1.54
Total MU3 Acres	142.6					
MU4						
Marsh	75	1.81	1.27	1.48	0.148	11.10
Sedge Meadow	4	3.82	3.31	3.6	0.36	1.44
Wet Prairie	20	3.00	2.40	2.7	0.27	5.40
Wet Mesic Prairie	13.8	3.33	3.33	3.33	0.333	4.60
Mesic Prairie	8	3.22	3.22	3.22	0.322	2.58
Dry Mesic Prairie	10	3.52	3.52	3.52	0.352	3.52
Floodplain Forest	10.7	1.73	1.50	1.54	0.154	1.65
Total MU4 Acres	141.5					

MU# - Management Unit

Mean C – Mean Coefficient of Conservatism

FWOP – Future Without-Project

AA – Average Annual

HSI – Habitat Suitability Index

HU – Habitat Unit

Hine's Emerald Dragonfly

According to the experts, the population of Hine's Emerald Dragonfly is declining at LPNP. Dr. Soluk has been monitoring the population for a significant period of time and has noticed a decline from a mean stream density of 6-8 larva/m² to 1-2 larva/m², for an average loss of 5-4 larva/m² over the years. This information has raised a serious red flag over the viability of the endangered dragonfly's population at LPNP.

Conditions for the continued success of this species are linked to the overall ecological health of LPNP and the surrounding region. For instance, the hydroperiod needed for high reproductive success within the rivulets requires a number of days with dry conditions. This is believed to keep other predators from competing with the larva for prey items. However, too many dry days in one season can lead to higher mortality rates for the larvae. Also, high abundance of non-native plant species seems to have a negative effect on the survival of larvae. Additionally, the abundance of native crayfish burrows is important habitat for the larvae. Plus, enough cool water (groundwater) entering the rivulets to provide a slow moving current and the ability to buffer against high day time temps is required.

Changes in the hydroperiod of the seeps could have a negative impact on the ability of the seep fed rivulets to provide suitable habitat conditions. If less water is discharged from the seeps, by way of lowering the amount of water recharging the aquifer, this would result in less cool groundwater entering the rivulets and an increase in the number of dry days. Non-native/invasive species represent a large threat, related to increased human development of the surrounding area, if allowed to colonize and could eventually displace the native species from the streamlet areas. All these events, less groundwater entering system, increase in number of dry days and increase in non-native/invasive species could result in a complete failure of the rivulets to provide the required conditions for successful reproduction and in turn this would cause an extirpation of the Hine's Emerald Dragonfly from LPNP.

In summation, the future of the plant and animal communities at LPNP will not simply remain at the current status, but will consistently degrade throughout the coming years if nothing is done to reverse and/or moderate the existing problems at a watershed scale. No segment of land or natural community is independent of the changes occurring within its watershed. This relationship could not be better illustrated at LPNP. Although land managers have been proactive in the preservation these communities, forces outside of the limits of LPNP have formed a significant threat to the continued success of the biological communities at LPNP. Future conditions will include a decrease in the amount of groundwater entering the site, increased competition from invasive species and more influence of surface water. Without implementation of the proposed project the results would include: degraded, poor quality plant communities, probable extirpation of endangered and threatened species and an overall decrease in the level of ecological integrity of the site.

CHAPTER 3 – Problems & Opportunities

This chapter provides a description of identified problems within the study area along with opportunities for improvement. It also outlines the overall project goal along with a list of planning objectives and constraints.

3.1 Problems and Opportunities

An endangered species is classified as being in danger of becoming extinct throughout all or a significant portion of its range. The cause of a species decline is typically from human activity. There are three federally listed species that occupy LPNP. One overriding reason for the classification of these three species at LPNP is the extent and intensity of human activity, namely agricultural production, within the Midwest Region. The Midwest has lost a significant amount of natural land cover through draining and plowing under of native vegetation and replacement with agricultural commodities. The dominant land cover type prior to settlement of the Midwest was prairie. The three endangered species present within LPNP are prairie and wet prairie dependent, meaning their only suitable habitat is within a prairie. Today there is estimated to be 1%-4% of prairie left in fragmented small habitat patches. Without large-scale efforts to restore native wetland and prairie back to the landscape, wetland and prairie dependent species will continue to be threatened with extinction and have no viable way to recover. LPNP and PBP represent one of the remaining wetland/prairie complexes left in the Midwest. This project represents a critical opportunity to provide restored acres of wetland and prairie for a variety of native plants and wildlife, especially endangered species.

3.1.1 - Study Area Problems

The study area has been studied intensively in the last few decades. In recent years, the FPDWC and other observers have noted a decrease in the amount of ground water that discharges into the site, specifically during the summer months. This decrease in groundwater has resulted in decreased abundance for some of the rare species that inhabit the site, especially the federally listed Hine's Emerald Dragonfly and the state listed Blanding's Turtle. The reason for the decrease in groundwater discharge is primarily related to land use within the recharge zone of the aquifer feeding the groundwater at LPNP (Figure 4). Much of the recharge zone is in agricultural production and much of PBP is within the recharge zone. The current farming practice includes the application of fertilizer that is then worked into the soil with a deep disking technique. This disking technique is believed to have caused a layer of compaction approximately 6-12" below the surface. In addition to the farming techniques, the area is artificially drained by many feet of drainage tiles. Lastly, the current rotational crops of soybeans and corn are annual species that have dense but shallow root systems. Annual crops do not function in the same manner as native prairie vegetation. Native vegetation have dense but very deep root networks that allow for higher rates of water to infiltrate deeper into the soil and have greater potential for recharge of the aquifer. Changes to vegetation, farming techniques and artificial drainage have decreased the rate of water reaching the aquifer within the recharge zone of LPNP. Less water reaching the aquifer has resulted in changes in the amount of groundwater discharging during the summer months within LPNP. If groundwater feed rivulets and wetlands dry up too early in the year, species such as Hine's Emerald Dragonfly become stressed and this type of stress can result in mortality.

In addition to human activities within PBP, development of the area within LPNP watershed has led to altered hydrology. Changes to the landscape, such as increased area of impervious surfaces, increased number of private and municipal well and diversion of storm water has also resulted in a loss of water infiltration to the aquifer. The change in land use correlates to the decrease in water discharging into LPNP, which affects three federally listed species, as well as the rare and unique native prairie communities.

PBP lacks the cover of high quality native vegetation. This is not only a problem in the sense that it reduces the ability of the site to retain and infiltrate water into the aquifer, it also limits the ability of resident and migratory birds species to use PBP for reproduction and refuge during migration. Grassland and shrubland breeding bird populations have been and continue to decline within North America. Population declines are mainly because of loss of habitat to agricultural production within their breeding ranges. Another limiting factor is their reliance on large uninterrupted tracks of grassland. Large contiguous parcels of native grassland are rare within the Midwest Region. PBP's lack of high quality native vegetation does not support important grassland and shrubland breeding birds.

Increasingly invasive species pose a significant threat to the flora and fauna that inhabit LPNP. When the LPNP was first discovered and efforts were made to place this site under protection, site stewards were aware of the non-native shrubs that had invaded and were shading out native vegetation. Stewards worked to remove non-native shrubs and were successful for a time in the drier areas. However, small patches remained and have begun to slowly enlarge their area of influence once again. Non-native shrubs have also been introduced into the forested floodplain habitat along the Des Plaines River. Introduction has been primarily through seed floating in with flood waters and animals that eat the fruit from one area and transport the seed into another. Although non-native shrubs pose a significant threat, the newly invading Cattails (*Typha spp.*) and Common Reed (*Phragmites australis*) are now a dominant presence throughout the aquatic and semi-aquatic habitats in LPNP. This is especially alarming because the Hine's Emerald Dragonfly depends on native wetland vegetation for successful reproduction. Competition from the invasive Cattails and Common Reed has begun to displace native wetland grasses and sedges, the primary habitat of the Hine's Emerald Dragonfly. Invasive species has decreased the quality of the native vegetation, decreased the diversity of the native plant communities and decreased the suitability of wetland habitat for the Hine's Emerald Dragonfly.

Lastly, the influence of non-native shrubs along the embankment adjacent to Route 53, referred to as the Oak Savanna, has displaced the native herbaceous layer. Loss of the herbaceous layer has resulted in mostly bare dirt beneath the shrub canopy. Areas along Route 53 within the Oak Savanna experience episodes of runoff from the roadway during rain events. These runoff events and loss of the herbaceous layer has resulted in a small area of soil erosion within the Oak Savanna. A small gully has formed and has been transporting sediment down slope and into the wetland areas. Soil erosion and sediment transport has resulted in disturbed areas within the vulnerable LPNP wetlands. Disturbances of this type only facilitate invasive species (e.g., soil/sediment disturbance) and make the removal of invasive species difficult because of the continual influx of sediment from slopes.

Based on site investigations and studies the main problems at the LPNP and PBP in which the 206 Authority may address are as follows:

- Hydrogeomorphic conditions that limit water infiltration within PBP, such as drainage tiles, farming practices and lack of native vegetation
- High abundance of invasive plant species which displace native vegetation, reduce diversity of native plant communities and reduce the suitability of habitat for Hine's Emerald Dragonfly
- Soil erosion and lack of herbaceous plant species in understory in Oak Savanna
- Lack of high quality habitat for breeding grassland and shrubland birds

3.1.2 - Opportunities

LPNP is an important part of the ecological and historical heritage of the region. In addition to the LPNP, the project site includes the 623.7-acre PBP that hosts high intensity farming practices within the groundwater recharge zone of the LPNP. This presents a significant opportunity to increase the volume of water available to infiltrate and recharge the subsurface aquifer. Restoration of PBP back to natural communities, such as wetlands and associated wetland buffer areas with deep rooted native species has ecological value for both the LPNP and its federally listed species and connectivity of the watershed. As a result, grassland, shrubland bird species of special concern would be able to utilize the newly restored habitat, as well as, providing recreational opportunities to the local municipalities. Plus, on-site opportunities to protect and restore include improving the habitat by: improving the quality of surface water entering the low-lying areas through preventing sediment and pollutant influx and restoring historical surface water hydrology. There is also opportunity for the removal of highly competitive invasive species that disrupt the function of the aquatic ecosystem and the restoration of native plant communities. To restore the wetland areas that support the Hine's Emerald Dragonfly requires the restoration of the hydrology of the groundwater recharge area for LPNP.

- The increase in suitable habitat for federally listed species, such as the Hine's Emerald Dragonfly.
- The increase in area of suitable habitat for wetland adapted species.
- The increase in habitat connectivity within the watershed.
- The removal of a population of invasive species.
- The increase in opportunities for recreation for local residence.

3.2 Planning Goals, Objectives & Constraints

3.2.1 - Goals

The study goal of this detailed project report is to determine the most beneficial and cost effective alternatives for the restoration of the hydrology and vegetation for the protection of the federally endangered Hine's Emerald Dragonfly. The ecosystem restoration goal of this project is to restore and protect biodiversity and the Federal and State endangered species present.

3.2.2 - Objectives

Federal Ecosystem Objectives

The Federal objective of water and related land resources planning is to contribute to national economic and/or ecosystem development in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements and policies. The use of the term “Federal objective” should be distinguished from planning/study objectives, which are more specific in terms of expected or desired outputs whereas the Federal objective is considered more of a National goal. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study objectives and to the Federal objective. Contributions to national improvements are increases in the net value of the national output of goods, services and ecosystem integrity. Contributions to the Federal objective include increases in the net value of those goods, services and ecosystems that are or are not marketable.

Restoration of the Nation’s environment is achieved when damage to the environment is reversed, lessened, eliminated or avoided and important cultural and natural aspects of our nation’s heritage are preserved. The objectives and requirements of applicable laws and executive orders are considered throughout the planning process in order to meet the Federal objective. The following laws and executive orders that specifically provided guidance for this study include, but are not limited to:

- φ Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)
- φ Fish and Wildlife Coordination Act, as amended (16 USC 661)
- φ Migratory Bird Treaty Act of 1918, as amended (16 USC 703 et seq.)
- φ Responsibilities of Federal Agencies to Protect Migratory Birds (E.O. 13186)
- φ Clean Water Act of 1977, as amended (33 USC. 1251 et seq.)
- φ National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)
- φ Invasive Species (E.O. 13112)
- φ Nonindigenous Aquatic Nuisance Prevention & Control Act of 1990, as amended (16 U.S.C. 4701 et seq.)
- φ National Invasive Species Act of 1996 (Public Law 104 – 332)
- φ Protection of Wetlands (E.O. 11990)
- φ Protection and Enhancement of Environmental Quality (E.O. 11514)
- φ Protection and Restoration of the Great Lakes (E.O. 13340)
- φ Floodplain Management (E.O. 11988)
- φ Preparing the United States for the Impacts of Climate Change (E.O. 13653)

Responsibilities of Federal Agencies to Endangered Species (16 USC 1531 et seq.)

The Endangered Species Act of 1973 as amended states that species that are at risk of becoming extinct due to economic growth and development are to be conserved to the extent practicable. Furthermore it is the responsibility of all federal agencies to use their authorities to conserve endangered and threatened species.

- (c) Policy. – It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of this Act.

The LPNP and PBP restoration study/project has great potential to restore critical habitat for the Hine's Emerald Dragonfly as identified by the U.S. Fish and Wildlife and conserve habitat for the Leafy Prairie Clover and Lakeside Daisy.

Responsibilities of Federal Agencies to Protect Migratory Birds (E.O. 13186)

Migratory birds are of great ecological and economic value to this country and to other countries. They contribute to biological diversity and bring tremendous enjoyment to millions of Americans who study, watch, feed, or hunt these birds throughout the United States and other countries. The United States has recognized the critical importance of this shared resource by ratifying international, bilateral conventions for the conservation of migratory birds. Such conventions include the Convention for the Protection of Migratory Birds with Great Britain on behalf of Canada 1916, the Convention for the Protection of Migratory Birds and Game Mammals-Mexico 1936, the Convention for the Protection of Birds and Their Environment- Japan 1972, and the Convention for the Conservation of Migratory Birds and Their Environment-Union of Soviet Socialist Republics 1978.

These migratory bird conventions impose substantive obligations on the United States for the conservation of migratory birds and their habitats, and through the Migratory Bird Treaty Act (Act), the United States has implemented these migratory bird conventions with respect to the United States. This Executive Order directs executive departments and agencies to take certain actions to further implement the Act...

(g) "Federal agency" means an executive department or agency, but does not include independent establishments as defined by 5 U.S.C. 104.

(h) "Action" means a program, activity, project, official policy (such as a rule or regulation), or formal plan directly carried out by a Federal agency. Each Federal agency will further define what the term "action" means with respect to its own authorities and what programs should be included in the agency-specific Memoranda of Understanding required by this order. Actions delegated to or assumed by nonfederal entities, or carried out by nonfederal entities with Federal assistance, are not subject to this order. Such actions, however, continue to be subject to the Migratory Bird Treaty Act.

The LPNP and PBP restoration study/project has great potential to provide critical migratory bird habitat as identified by the Field Museum of Natural History, Audubon Society, the USFWS and other local naturalist and birding groups.

Planning Objectives

As part of the USACE Civil Works mission, the federal objective of ecosystem restoration projects is to restore the structure, function and dynamic processes of degraded ecosystems to a less degraded, more natural condition. The non-Federal sponsor has an ecosystem restoration objective that partners well with the federal objective stated above. Study objectives are statements that describe the desired results of the planning process by solving the problems associated with the study purpose, problems and opportunities. Objectives must be clearly defined and provide information on the effect desired, the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

Three (3) planning objectives were identified by the study team, including the non-Federal sponsor and various stakeholders, to address the resource problems listed above:

Objective 1 – Reestablish Hydrogeomorphology to Support Natural Communities

The current condition of PBP has decreased the ability of this site to retain and infiltrate water to the aquifer, which has negatively impacted the groundwater discharge within LPNP. In addition, PBP contains poor habitat function and structure for resident and migratory wildlife and especially birds. Thus, changes to the current hydrogeomorphic conditions at PBP would positively influence the hydrologic regime within LPNP and support a high quality diverse natural community. These effects would be sustained over the life of the project and optimistically in perpetuity. This objective seeks to reestablish natural hydrogeomorphic structure and parameters to support wetland and wet prairie habitats within PBP and by extension LPNP. Improvement is predicted via the increase in quality (FWP HSI (FQI)) of native plant communities.

Objective 2 – Eradicate Invasive Species from All Plant Communities

Currently, LPNP wetland community types (e.g., marsh, floodplain forest, etc.) are dominated by non-native and invasive plant species. This condition resulted from a variety of sources, such as lack of appropriate management, floodwaters and seed dispersal, etc. The domination of plant communities by certain species such as Cattails, Common Reed, and European Buckthorn have displaced native plant species, indirectly caused increased erosion and decreased the suitability of critical habitat of the Hine's Emerald Dragonfly. Also, PBP is currently dominated by non-native agricultural crops that provide poor habitat quality to native wildlife species. Thus, the changes to the native plant community via removal and control of invasive plant species will assist in the reestablishment of a diverse high quality native plant community matrix that will support the Hine's Emerald Dragonfly (within LPNP) and important resident and migratory species (within PBP). Improvement is predicted via the increase in quantity (acres of native plant dominance) and increase in quality (FWP HSI (FQI)) of native plant communities.

Objective 3 – Restore and Propagate Diverse Native Plant Communities

The current condition of many plant communities (e.g., marsh, floodplain forest, etc.) within the project site are characterized as fair to very poor. Poor habitat conditions are the result of invasive plant species, alterations to the hydrologic regime and loss of native plant species. The restoration of healthy and diverse native plant communities via native plant seed and live plugs, in conjunction with the restoration of the hydrologic regime and removal of invasive species, will support the Hine's Emerald Dragonfly (within LPNP) and important resident and migratory species (within PBP). These effects would be sustained and increased over the life of the project and optimistically in perpetuity via minor maintenance and, when necessary, additional native plantings by the FPDWC. This objective seeks to reestablish native plant community richness and structure to support critical wetland and grassland habitats within LPNP and PBP. Improvement is predicted via the increase in quantity (acres of native plant dominance) and increase in quality (FWP HSI (FQI)) of native plant communities.

3.2.3 - Constraints

Site-specific constraints to project implementation are:

- Planning measures constrained by active rail road line through critical habitat zone, aquifer pumping, and active floodplain of the Des Plaines River
- Minimize disturbance to federally-listed, state-listed, and rare species from any alternative plan.
- Avoid permanent negative impact to habitat of federally listed, state listed and rare species from any alternative plan.
- Avoid measures with large O&M costs.
- Prevent net increase in wildlife hazards to nearby Lewis University Airport.

Chapter 4 – Plan Formulation and Evaluation

The formulation, evaluation, and comparison of alternative plans comprise the third, fourth, and fifth steps of the Corps' planning process. These steps are often referred to collectively as plan formulation. Plan formulation is an iterative process that involves cycling through these steps to develop a reasonable range of alternatives, and then narrow those plans down to a final plan, which is feasible for implementation.

Plan formulation for ecosystem restoration (ER) presents a challenge because alternatives have non-monetary benefits. To facilitate the plan formulation process, the methodology outlined in the Corps' Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," 1 May 2003 was used. The steps in the methodology are summarized below:

1. Identify a primary project purpose. For this portion of the study, ecosystem restoration (ER) is identified as the primary purpose.
2. Formulate management measures to achieve planning objectives and avoid planning constraints, where measures are the building blocks of alternative plans.
3. Identify and select those sites most beneficial for ecological restoration.
4. Formulate, evaluate, and compare an array of alternatives to achieve the primary purpose (ER) and identify cost effective plans.
5. Perform an incremental cost assessment on the cost effective plans to determine the NER plan.

4.1 – Measure Identification

In general, each specified measure takes into account the repair of the physical environment and the subsequent reestablishment of high quality native plant communities. The following measures are based on a collaborative effort between the USACE and the FPDWC. Measures were developed with the intent to restore habitat structure and function in a sustainable fashion. Table 5 presents the list of proposed measures that will be discussed further and their associated code that will be used in the upcoming IWR Planning Suite for the cost effective/incremental cost analysis.

The measures were developed to take into consideration the fact that the project encompasses multiple management units. Management units were designated based similarity of plant community type and on the problems located within certain areas. Management units are described in section 2.5.1 Habitat Assessment Methodology and mapped Figure 7.

Table 4. List of Proposed Restoration Measures and Associated Code

Restoration Measures		Management Units			
Description	Code	MU1	MU2	MU3	MU4
1. Drainage tile disablement	hydro	X			
2. Erosion Control of Eroded Area	erosion		X		
3. Woody Species Clearing	clear		X	X	X
4. Selective Mowing	mow	X			
5. Herbicide Application	herb	X	X	X	X
6. Prescribed Burns	burn	X	X	X	X
7. Installation of Native Plants	plant	X	X	X	X

*Hydrology*1. Drainage Tile Disablement (hydro)

Drain tile disablement is recommended as a measure to restore the natural hydrology at PBP, which is referred to as Management Unit 1 (MU1). A site-specific study was performed by the FPDWC to insure off-site impacts would not be incurred and the drain tiles were surveyed and mapped to ensure proper disablement. The plan will be to install water control valves at certain intervals to back up water in appropriate locations. This measure will result in the restoration of the hydrology within PBP. Once hydrology is naturalized, wetlands will be reestablished, water will be retained for longer periods and will increase the amount of water available to infiltrate to the groundwater table that discharges to Lockport Prairie. This measure will address a primary problem within the project area because this will increase the amount of water available to infiltrate to the groundwater table that is a significant portion of the critical recharge zone for Lockport Prairie. The result will ensure the reestablishment of important wetlands within PBP and naturalize the critical recharge zone of Lockport Prairie. This measure is dependent on native plant installation.

*Erosion*2. Erosion Control of Eroded Area (erosion)

There is an area between Route 53 and Division Street, within MU 2 (LPNP North), which receives on occasion high volumes of runoff and has resulted in the formation of a gully. The area is roughly 1/6-acre in size. This area contains high coverage of invasive woody species that has resulted in mostly bare soil underneath woody species. Bare soil combined with periodic high runoff has resulted in unnatural erosional activity. To alleviate this condition, erosion control measures will be installed. This will consist of removal of all woody plant species, which is a mixture of thick shrubby understory with approximately 20 medium to large trees. After removal an erosion control blanket will be placed. Native plant installation within this area is covered under a different measure. As a result of erosion control this area will no longer act as a source of excess sediment entering the wetland communities of LPNP and ensure that the current gully does not expand to engulf and degrade more oak savanna. This measure is dependent on woody species clearing and native plant installation.

Woody Species Clearing

3.1 Tree Clearing (clear)

This measure consists of removing secondary forest regrowth within the southernmost area of MU 4. All woody species will be cut flush with the ground and cut stump treated with an herbicide to prevent regrowth. This work would be done during the winter months. This area is generally marsh and floodplain and requires a hardened surface to move heavy machinery. The forest is a mixture of a few large trees and mostly medium sized trees, average DBH is 8". Follow up herbicide application to resprouts will occur every year of project. This will consist of all areas that were cleared being sprayed with foliar herbicide by hand held equipment twice a year the first year after removal. After the initial follow up herbicide, small patches would be treated once a year for the remainder of contract. Removal of secondary forest regrowth will open up the canopy to allow light to penetrate to the herbaceous layer. As light increases there is a greater probability that the native herbaceous plant layer will reestablish once native plants are installed. This measure is dependent in selective removal of shrub species.

- Species to be removed include aggressive native species, Green ash (*Fraxinus pennsylvanica*), and non-native invasive species, Black locust (*Robinia pseudoacacia*).

3.2 Selective Removal of Shrub Species (clear)

This measure consists of removing selective woody species within MU2, MU3 and MU4. Selective removal will be mostly focused on invasive shrub species within the Oak Savanna area of MU2 and within the areas of MU3 and MU4. Shrubs can be cleared with small maneuverable machinery (MU3 and MU4) and by hand held equipment for hard to reach places along the bluff (MU2). All woody species will be cut flush with the ground and cut stump treated with an herbicide to prevent regrowth. This work would be done during the winter months. Follow up herbicides to resprouts will occur every year of project. This will consist of all areas that were cleared being sprayed with foliar herbicide by hand held equipment twice a year the first year after removal. After the initial follow up herbicide, small patches would be treated once a year for the remainder of contract. The result of selective shrub removal will increase light and nutrient availability to the native herbaceous layer. This measure will address problems that relate to native plant community degradation and allow the recovery of high quality native plant communities within LPNP. This measure is dependent on tree clearing.

- Species to be removed include aggressive native species, Gray dogwood (*Cornus racemosa*), and non-native invasive species, European buckthorn (*Rhamnus cathartica*).

Invasive Species Removal

4. Selective Mowing (mow)

In MU1 mowing will be used to control annual and biennial weeds before and for one year after the initial native seed installation. Mowing consists of a front loaded or pull behind mower on a medium sized tractor. During the second year of contract at most 350-acres would be mowed at least once during the year. This would occur only within MU1 and as former agricultural field, machinery would be easy to maneuver within this area. This measure is designed to be coupled with the native plant installation measure. The result of this measure will increase the rate of establishment of the restored native plant communities within MU1 as

there will be less competition between newly establishing native plants and non-native weedy plants. This measure is dependent on drain tile disablement and native plant installation.

- Species to be targeted for mowing include aggressive native species, Tall goldenrod (*Solidago altissima*), and non-native weedy species, Queen Anne's lace (*Daucus carota*).

5. Herbicide Application for Herbaceous Species (herb)

1. MU1 (PBP) may have large-scale broadcast application of herbicides to treat problem areas prior to native plant installation. Areas to be treated are small and patchy across the landscape. Approximately 200-acres would be treated with boomspray mounted on a tractor. During years 2-5 of contract, more selective methods would be used, such as hand held equipment, such as back pack sprayers, brush cutters, hand wick and ATV mounted boomsprayers. Crews would be around 3 to 4 in size and would spend 8 hours treating areas on average 3 days a week during the growing season (May-October) in years 2-3 and an average of 2 days per week during years 4 and 5 of contract. These methods would be used to treat all 623-acres during years 2-5 for contract. Controlling invasive plant species during the first 5-years of restoration is critical for the success of native plant restorations. Without control efforts, invasive species would dominant and out compete native plant species, resulting in a poor quality habitat for native wildlife species. This measure is dependent on drain tile disablement, prescribed burning and native plant installation.

2. MU2 does not contain many native sensitive species; therefore, during year 1 of contract, boom sprayers mounted on an ATV may be used to treat problem areas. After native plant installation, most areas would be treated with hand held equipment in years 2-5 of contract. A crew of 2 or 3 would spend 8 hours once per month during the growing season within this unit to treat invasive species. This measure would ensure that the native plant restoration would become native dominated and provide a high quality oak savanna habitat for native wildlife species. This measure is dependent on woody species removal, prescribed burning and native plant installation.

3. Approximately 100-acres of this area (MU2) contains habitat suitable for federally listed species, therefore, no broadcast method of herbicide will be allowed. Within the sensitive areas, only hand held directed herbicide application will be used. Most of the sensitive area is covered in cattails that will have to be sprayed with a back pack sprayer or hand wicked. This is time intensive work and may require a crew of 4 spending 8 hours 3 times a week during the growing season for the years 1 and 2 of the contract. During years 3-5 the average number of days per week should steadily decrease. In areas along the Des Plaines River there is less concern of impact to sensitive species; therefore, broadcast methods of herbicide can be used during year 1 of contract. During years 2-5 of contract, more selective methods will be used as native plant species become more numerous. A crew of 2 or 3 would spend 8 hours once per month during the growing season within this area to treat invasive species. Controlling invasive plant species would address one of the primary problems within the LPNP. Native plants will be able to recover from the seed bank in some areas they had been previously because of the presence of invasive species. In areas that have had long-term infestations of invasive species, such as the marsh, sedge meadow and wet prairie the native seed bank has been depleted and will require native plant installation to spur the recovery of these areas. This measure is dependent on prescribed burns, woody species removal and native plant installation.

4. MU4 is similar to MU3 in that there are large areas, approximately 100-acres, that contain

federally listed species and areas along the river that do not contain sensitive species. Within the sensitive areas, only hand held directed herbicide application will be used. In areas along the Des Plaines River there is less concern of impact to sensitive species; therefore, broadcast methods of herbicide can be used during year 1 of contract. During years 2-5 of contract, more selective methods will be used as native plant species become more numerous. Benefits derived from controlling invasive species include higher quality native plant communities and higher probability of successful recovery of a high quality wildlife habitat. This measure is dependent on prescribed burns, woody species removal and native plant installation.

Native Plant Reestablishment

6. Prescribed Burns (burn)

All areas that can be burned within the project area should be burned twice during construction. Lockport Prairie (MU2, MU3 and M4) will have a few more restrictions on the timing of burns (e.g., avoid impacts to reptiles), but is fairly easy to burn because of the numerous naturally occurring fire breaks (e.g., Des Plaines River that forms the eastern border of LPNP). Prairie Bluff (MU1) will also be fairly easy to burn because it is mostly surrounded by agricultural fields or natural areas. Prescribed burns are a method to ensure good germination for native plant seeds, reduce competitive fire intolerant species (e.g., non-native shrubs) and increase rate of nutrient cycling. All of these are beneficial to the long term health and success of grassland species. Prescribed burning will help to address problems associated with non-native shrub cover and weedy fire intolerant herbaceous plant species that compete with native plants. This measure is linked to native plant installation.

7. Installation of Native Species (plant)

This measure addresses multiple problems within LPNP, such as the lack of high quality large continuous grassland and wetland habitat in MU1, lack of high quality oak savanna and marsh within MU2 and lack of high quality habitat within wet areas (marsh, sedge meadow and wet prairie) within MU3 and MU4. This measure would entail the installation of native plant seed and live plugs. Seed would be installed during the fall/winter months or otherwise known as dormant seeding. Live herbaceous plugs would be installed during the spring and early summer months for optimal growing season weather. Woody species installation, such as native trees and shrubs, would be generally installed during the fall or early winter months during their dormant season. Native plant installation is the quickest and most efficient method to restore a high quality native plant community within areas that have been highly degraded, such as former agricultural fields. Native plants will not be installed in areas that have a known extant native plant seed bank, such as the mesic and dry mesic prairie within MU3 and MU4. These areas are expected to recover after removal of non-native shrub species. This measure is dependent on drain tile disablement, woody species clearing and invasive species control. Long-term success of this measure is dependent on periodic prescribed burns.

- MU1 (623.7-acres) - native plant communities will be delineated by hydrologic regime of soil. Marsh, wet prairie, wet mesic prairie and mesic prairie will be planted with appropriate native plant species once drain tile disablement has been completed.
 - a. Marsh (80-acres) – This installation mix will be a mixture of live herbaceous plugs and seed that include: Common rush (*Juncus effusus*), Rice cut grass (*Leersia oryzoides*) and Swamp milkweed (*Asclepias incarnata*).

- b. Wet Prairie (115-acres) – This installation mix will also be a mixture of seed and minimal plugs that include: Monkey flower (*Mimulus ringens*), Riddell’s goldenrod (*Solidago riddellii*) and Common boneset (*Eupatorium perfoliatum*).
 - c. Wet Mesic Prairie (270.3-acres) – This installation will be mostly seed that include: Little blue stem (*Andropogon scoparius*), Foxglove beardtongue (*Penstemon digitalis*) and Compass plant (*Silphium laciniatum*).
 - d. Mesic Prairie (158.4-acres) – This installation will be all seed that include: Prairie dropseed (*Sporobolus heterolepis*), Virginia mountain mint (*Pycnanthemum virginianum*) and Wild quinine (*Parthenium integrifolium*).
- MU2 (19.7-acres) – This management unit contains both marsh and oak savanna, both communities are degraded and will require installation of native plants to achieve a high quality community.
- a. Marsh (4.5-acres) – This installation mix will be a mixture of live herbaceous plugs and seed that include: Common rush (*Juncus effusus*), Rice cut grass (*Leersia oryzoides*) and Swamp milkweed (*Asclepias incarnata*).
 - b. Oak Savanna (15.2-acres) – This installation will be mostly seed that include: Little blue stem (*Andropogon scoparius*), Foxglove beardtongue (*Penstemon digitalis*) and Compass plant (*Silphium laciniatum*).
- MU3 (142.6-acres) – This management unit contains both areas that will need to be planted and areas that will not need planting. Areas that will need planting are:
- a. Marsh (80-acres) - This installation mix will be a mixture of live herbaceous plugs and seed that include: Common rush (*Juncus effusus*), Rice cut grass (*Leersia oryzoides*) and Swamp milkweed (*Asclepias incarnata*).
 - b. Sedge Meadow (5-acres) – This installation will also be a mixture of live herbaceous plugs and seed that include: Purple-stem angelica (*Angelica atropurpurea*), Marsh brome (*Brome ciliatus*) and White meadowsweet (*Spirea alba*).
 - c. Wet Prairie (10-acres) – This installation will have seed and minimal live plugs that include: Monkey flower (*Mimulus ringens*), Riddell’s goldenrod (*Solidago riddellii*) and Common boneset (*Eupatorium perfoliatum*).
 - d. Floodplain Forest (10-acres) – This installation will have a mainly seed and some live plugs that include: Nodding bur-marigold (*Bidens cernua*), Upright sedge (*Carex stricta*) and Hard-stem bulrush (*Scirpus acutus*).
- MU4 (141.5-acres) – This management unit is very similar to MU3 in that it contains both areas that will need to be planted and areas that will not need planting. Areas that will need planting are:
- a. Marsh (75-acres) - This installation mix will be a mixture of live herbaceous plugs and seed that include: Common rush (*Juncus effusus*), Rice cut grass (*Leersia oryzoides*) and Swamp milkweed (*Asclepias incarnata*).
 - b. Sedge Meadow (4-acres) – This installation will also be a mixture of live herbaceous plugs and seed that include: Purple-stem angelica (*Angelica atropurpurea*), Marsh brome (*Brome ciliatus*) and White meadowsweet (*Spirea alba*).
 - c. Wet Prairie (20-acres) – This installation will have seed and minimal live plugs that include: Monkey flower (*Mimulus ringens*), Riddell’s goldenrod (*Solidago riddellii*) and Common boneset (*Eupatorium perfoliatum*).

- d. Floodplain Forest (10.7-acres) – This installation will have a mainly seed and some live plugs that include: Nodding bur-marigold (*Bidens cernua*), Upright sedge (*Carex stricta*) and Hard-stem bulrush (*Scirpus acutus*).

Table 5. Combined Dependent Measures

Code	Measures	Acres
MU2-Shrubs	MU2 - clear	19.7
MU3-Shrubs	MU3 - clear	142.6
MU4-Shrubs	MU4 - clear	141.5
MU1-Full	MU1 - drain tile, clear, mow, herb, burn, plant	623.7
MU2-Full	MU2 - erosion, clear, herb, burn, plant	19.7
MU3-Full	MU3 - clear, herb, burn, plant	142.6
MU4-Full	MU4 - clear, herb, burn, plant	141.5

Refer to Figure 7 for Management Units

4.2 – Measure Costs & Assumptions

Detailed discussion on planning level feature costs is presented in Appendix C – Cost Engineering. Conceptual, planning level cost estimates were prepared for measures/features that were identified by the study team in conjunction with the non-Federal sponsors. These cost estimates do not represent complete project construction cost estimates, but rather individual measures of work or components of the entire project. The measures were used to provide an economic basis for the development of project alternatives. Once the project alternatives have gone through the plan formulation process, and additional design information was developed for the recommended plan, a more detailed and reliable cost estimate was performed (Appendix C). Estimates were developed using cost information from previous studies, lump sum and unit prices, and for plant, labor and material methods. A 25% contingency was applied to all measures. Planning level unit costs were placed into a matrix to utilize the different costs for each measure of work.

Cost Annualization: Annualizing costs is a method whereby the project costs are discounted to a base year then amortized over the period of analysis. The base year for this project was determined to be the year in which the first phase of the project is to be completed (calendar year 2015). Costs that occur prior to this year need to be compounded to the base year, while those occurring after the base year need to be discounted to the base year. The period of analysis for the Section 506 project is 50 years. The present value method was used to discount future costs to the base year. Costs are compounded or converted to present value for the base year then amortized over the 50-year period of analysis to give the annual cost. The discount rate was determined by the Economic Guidance Memorandum 15-01 to be 3.375%. The method shown in the above table does this for each measure. The individual measures of the project have the construction period spread out over 3 to 5-years, depending on magnitude or redundancy of the activity. Each year of every measure is either compounded or discounted to the base year. Calculation of the measures Average Annual Cost (AA Cost) is completed by multiplying the present value to the 50-year amortization factor. Total Construction and AA Cost per measure is presented in Table 7.

Real Estate: Plan formulation of the lands necessary to implement measures for this ecosystem restoration project was included in the Average Annual costs per measure. The current Real

Estate Plan provided by the real estate section determined \$ [REDACTED] per acre to accomplish plan formulation. Table 6 presents Real Estate values per measure.

Table 6. Real Estate Values for Cost Annualization

Code	Measures	Acres	Real Estate
MU2-Shrubs	MU2 - clear	19.7	[REDACTED]
MU3-Shrubs	MU3 - clear	142.6	[REDACTED]
MU4-Shrubs	MU4 - clear	141.5	[REDACTED]
MU1-Full	MU1 - drain tile, mow, herb, burn, plant	623.7	[REDACTED]
MU2-Full	MU2 - erosion, clear, herb, burn, plant	19.7	[REDACTED]
MU3-Full	MU3 - clear, herb, burn, plant	142.6	[REDACTED]
MU4-Full	MU4 - clear, herb, burn, plant	141.5	[REDACTED]

Table 7. Total Construction Costs and AA Costs per Measure

Code	Measures	Acres	Construction	AA Cost
MU2-Shrubs	MU2 - clear	19.7	[REDACTED]	\$ 19,995.19
MU3-Shrubs	MU3 - clear	142.6	[REDACTED]	\$ 75,611.41
MU4-Shrubs	MU4 - clear	141.5	[REDACTED]	\$ 81,426.70
MU1-Full	MU1 - drain tile, mow, herb, burn, plant	623.7	[REDACTED]	\$ 390,702.62
MU2-Full	MU2 - erosion, clear, herb, burn, plant	19.7	[REDACTED]	\$ 27,304.16
MU3-Full	MU3 - clear, herb, burn, plant	142.6	[REDACTED]	\$ 129,065.73
MU4-Full	MU4 - clear, herb, burn, plant	141.5	[REDACTED]	\$ 133,320.89

4.3 – Habitat Measures Benefits

The evaluation of habitat benefits is a comparison of the with-project and without-project conditions for each measure. Environmental outputs are the desired or anticipated measurable products or results of restoration measures and plans. The term “outputs” is often used interchangeably with “benefits” or “habitat units (HUs).” Ecosystem restoration proposals may possess multiple output categories, as well as other effects that may need to be considered, but the evaluation must at least address cost and an output category that has been determined to represent reasonable ecosystem restoration benefits. A comparison of the future without-project and future with-project HUs was performed in order to determine if a measure, or group of measures, will actually have beneficial effects to the Lockport Prairie ecosystem. The measures for this study were evaluated with the HSI methodology described in Section 2.5.1 (Habitat Assessment Methodology). Tables 8 and 9 present Future With Project (FWP) habitat benefits derived from the proposed measures.

Table 8. Habitat Benefits from Shrub (Shrubs) Removal

Measures	Community type	Acres	FWP AA MEAN C	FWP HSI	FWP HU	FWOP AA Mean C	FWOP HSI	FWOP HU	Net HU
MU2-Shrubs	Oak Savanna	15.2	1.98	0.20	3.01	1.33	0.133	2.02	0.99
	Marsh	4.5	1.83	0.18	0.82	1.48	0.148	0.67	0.16
	TOTAL	19.7							1.15
MU3-Shrubs	Marsh	80	1.83	0.18	14.64	1.48	0.148	11.84	2.80
	Sedge Meadow	5	3.85	0.39	1.93	3.6	0.36	1.80	0.13
	Wet Prairie	10	3.24	0.32	3.24	2.7	0.27	2.70	0.54
	Wet Mesic Prairie	15.6	3.53	0.35	5.51	3.33	0.333	5.19	0.31
	Mesic Prairie	7	3.51	0.35	2.46	3.22	0.322	2.25	0.20
	Dry Mesic Prairie	15	3.63	0.36	5.45	3.52	0.352	5.28	0.17
	Floodplain Forest	10	2.05	0.21	2.05	1.54	0.154	1.54	0.51
	TOTAL	142.6							4.66
MU4-Shrubs	Marsh	75	1.83	0.18	13.73	1.48	0.148	11.10	2.63
	Sedge Meadow	4	3.85	0.39	1.54	3.6	0.36	1.44	0.10
	Wet Prairie	20	3.24	0.32	6.48	2.7	0.27	5.40	1.08
	Wet Mesic Prairie	13.8	3.53	0.35	4.87	3.33	0.333	4.60	0.28
	Mesic Prairie	8	3.51	0.35	2.81	3.22	0.322	2.58	0.23
	Dry Mesic Prairie	10	3.63	0.36	3.63	3.52	0.352	3.52	0.11
	Floodplain Forest	10.7	2.05	0.21	2.19	1.54	0.154	1.65	0.55
	TOTAL	141.5							4.97

Table 9. Habitat Benefits from Full (Full) Restoration

Measures	Community type	Acres	FWP AA MEAN C	FWP HSI	FWP HU	FWOP AA Mean C	FWOP HSI	FWOP HU	Net HU
MU1-Full	Marsh	80	5.06	0.51	40.48	0.42	0.04	3.36	37.12
	Wet Prairie	115	4.91	0.49	56.47	0.42	0.04	4.83	51.64
	Wet Mesic Prairie	270	4.33	0.43	117.04	0.42	0.04	11.35	105.69
	Mesic Prairie	158	5.28	0.53	83.64	0.42	0.04	6.65	76.98
	TOTAL	624							271.42
MU2-Full	Oak Savanna	15.2	4.71	0.47	7.16	1.33	0.13	2.02	5.14
	Marsh	4.5	4.62	0.46	2.08	1.48	0.15	0.67	1.41
	TOTAL	19.7							6.55
MU3-Full	Marsh	80	4.62	0.46	36.96	1.48	0.15	11.84	25.12
	Sedge Meadow	5	4.89	0.49	2.45	3.60	0.36	1.80	0.65
	Wet Prairie	10	3.71	0.37	3.71	2.70	0.27	2.70	1.01
	Wet Mesic Prairie	15.6	4.05	0.41	6.32	3.33	0.33	5.19	1.12
	Mesic Prairie	7	4.10	0.41	2.87	3.22	0.32	2.25	0.62
	Dry Mesic Prairie	15	4.07	0.41	6.11	3.52	0.35	5.28	0.83
	Floodplain Forest	10	3.87	0.39	3.87	1.54	0.15	1.54	2.33
	TOTAL	143							31.67
MU4-Full	Marsh	75	4.62	0.46	34.65	1.48	0.15	11.10	23.55
	Sedge Meadow	4	4.89	0.49	1.96	3.60	0.36	1.44	0.52
	Wet Prairie	20	3.71	0.37	7.42	2.70	0.27	5.40	2.02
	Wet Mesic Prairie	13.8	4.05	0.41	5.59	3.33	0.33	4.60	0.99
	Mesic Prairie	8	4.10	0.41	3.28	3.22	0.32	2.58	0.70
	Dry Mesic Prairie	10	4.07	0.41	4.07	3.52	0.35	3.52	0.55
	Floodplain Forest	10.7	3.87	0.39	4.14	1.54	0.15	1.65	2.49
	TOTAL	142							30.83

4.4 – Alternative Plan Generations

Seven (7) measures, including the No Action measure, were input into the IWR-Planning Suite in terms of costs and benefits. Table 10 presents the Net AAHU and AA Cost per measure that was used to formulate alternative plans in the IWR Planning Suite. Measure MU2-Shrubs was not combinable with MU2-Full. MU3-Shrubs was not combinable with MU3-Full and MU4-Shrubs was not combinable with MU4-Full.

Based on these inputs and criteria, the IWR Planning software generated fifty-four (54) alternative combinations for ecosystem restoration. These alternative combinations were processed for Cost Effectiveness analysis via the Certified IWR Planning Suite Cost Effective and Incremental Cost Analysis, which are presented in the following sections.

Table 10 . Net AA Habitat Unit (Net AA HU) and AA Cost per Measure (AA Cost)

Code	Measures	Net AA HU	AA Cost
MU2-Shrubs	MU2 - clear	1.15	\$ 19,995.19
MU3-Shrubs	MU3 - clear	4.66	\$ 75,611.41
MU4-Shrubs	MU4 - clear	4.97	\$ 81,426.70
MU1-Full	MU1 - drain tile, mow, herb, burn, plant	271.42	\$ 390,702.62
MU2-Full	MU2 - erosion, clear, herb, burn, plant	6.55	\$ 27,304.16
MU3-Full	MU3 - clear, herb, burn, plant	31.67	\$ 129,065.73
MU4-Full	MU4 - clear, herb, burn, plant	30.83	\$ 133,320.89

4.5 – Cost Effectiveness / Incremental Cost Analysis

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans according to USACE policy. First, it must be shown through cost effectiveness analysis that a restoration plan’s output cannot be produced more cost effectively by another alternative. *Cost effective* means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost. Subsequently, through incremental cost analysis, a variety of alternatives and various-sized alternatives are evaluated to arrive at a “best” level of output within the limits of both the sponsor’s and the USACE’s capabilities.

The subset of cost effective plans are examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called “best buys.” As a group of measures, they provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. The incremental analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

Cost Effectiveness

The cost effectiveness analysis was used to ensure that certain options would be screened out if they produced the same amount or less output at a greater cost than other options with a lesser cost. Fifty-four (54) alternative combinations were analyzed for cost effectiveness. Of these, twenty-six (26) cost effective combinations were identified (Figure 9), which is inclusive of the five (5) Best Buy Plans. The No Action plan is always deemed cost effective and a Best Buy Plan. Benefits ranged from 1.15 – 340.47 AAHUs and average annual costs ranged from \$19,995.19 - \$680,393.40. Twenty-eight (28) alternative combinations were screened out as non-cost effective.

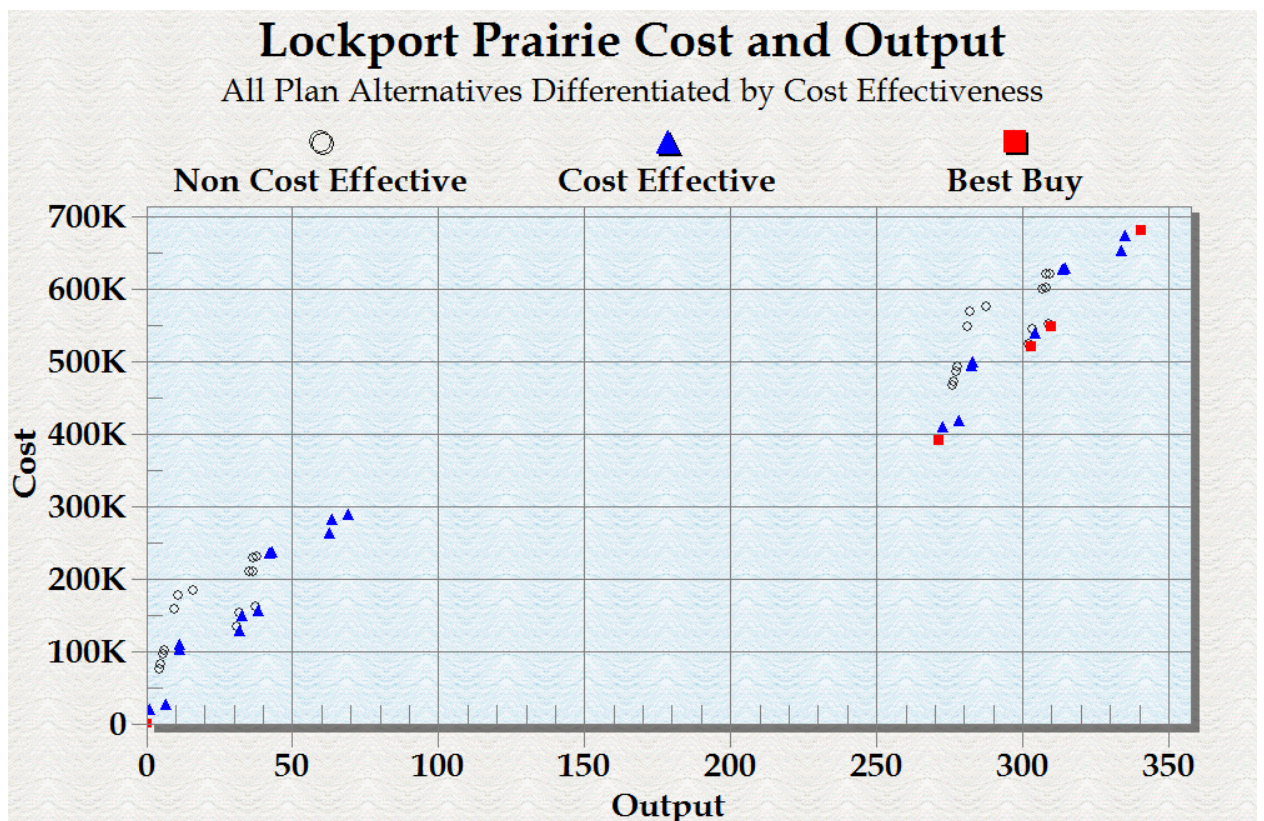


Figure 9. Cost Effectiveness

Incremental Cost Analysis

An incremental cost analysis was performed on the five (5) Best Buy Plans identified from the cost effectiveness analysis. The objective of the incremental cost analysis is to provide information to assist in determining whether the additional output provided by each successive cost effective plan is worth the additional cost that must be incurred for implementation; that is, to assist in determining the scale of the recommended plan. This incremental cost analysis (Table 11 and Figure 10) compares five alternative combinations for ecological restoration that were considered for selection of the National Ecosystem Restoration (NER) Plan.

Table 11. Summary of CE/ICA "Best Buy" Alternative Plans

Alt. Plan	Description	Net AA HU	AA Cost	Ave Cost/HU	Incremental Cost	Incremental Cost/HU
1	No Action	0	\$ -	\$ -	\$ -	
2	MU1-Full	271.42	\$ 390,702.62	\$ 1,439.48	\$ 390,702.62	\$ 1,439.48
3	MU1-Full, MU3-Full	303.09	\$ 519,768.35	\$ 1,714.90	\$ 129,065.73	\$ 4,075.33
4	MU1-Full, MU2-Full, MU3-Full	309.64	\$ 547,072.51	\$ 1,766.80	\$ 27,304.16	\$ 4,168.57
5	MU1-Full, MU2-Full, MU3-Full, MU4-Full	340.47	\$ 680,393.40	\$ 1,998.39	\$ 133,320.89	\$ 4,324.39

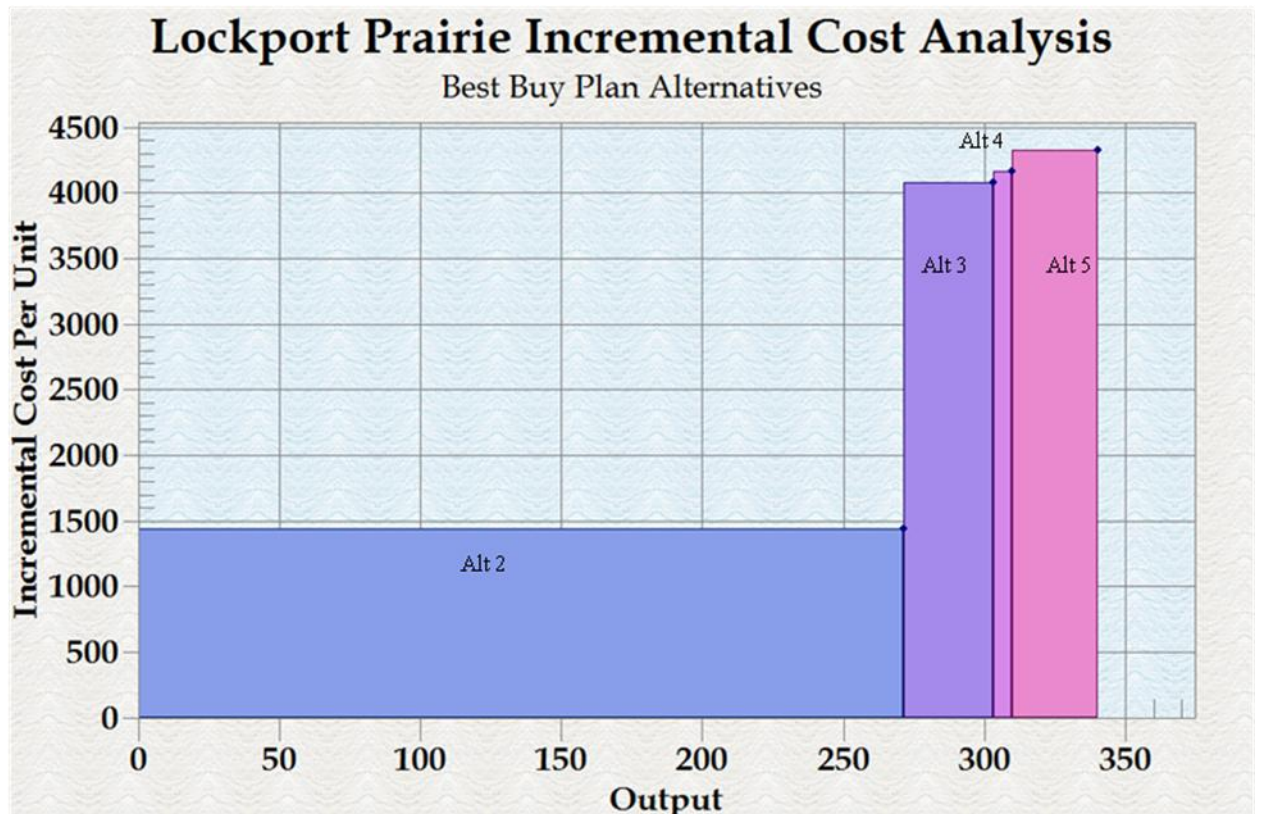


Figure 10. Incremental Cost Analysis

4.6 –Alternative Plan Trade-Off Analysis

Alternative plans that qualified for further consideration will be compared against each other in order to identify the selected areas of the project site and their associated alternatives to be recommended for implementation (Table 12). A comparison of the effects of various plans must be made and tradeoffs among the differences observed and documented to support the final recommendation. The effects include a measure of how well the plans do addressing the planning objectives including NER benefits and costs. Effects required by law or policy and those important to the stakeholders and public are to be considered. Previously in the evaluation process, the effects of each plan were considered individually and compared to the without-project condition. In this step, plans are compared against each other, with emphasis on the important effects or those that influence the decision-making process. The comparison step concludes with a ranking of plans.

Table 12. Alternative Plan Comparison

Alternative Plan	Description	Measures
1	No Action	NA
2	MU1-Full	MU1 - drain tile, mow, herb, burn, plant
3	MU1-Full, MU3-Full	Same as 2 plus - MU3 - clear, herb, burn, plant
4	MU1-Full, MU2-Full, MU3-Full	Same as 3 plus - MU2 - erosion, clear, herb, burn, plant
5	MU1-Full, MU2-Full, MU3-Full, MU4-Full	Same as 4 plus - MU4 - clear, herb, burn, plant

4.6.1 – Significance of Ecosystem Outputs

Because of the challenge of dealing with non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem outputs will help determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended. Statements of significance provide qualitative information to help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. The significance of the Lockport Prairie restoration outputs are herein recognized in terms of institutional, public, and/or technical importance.

Institutional Recognition

Institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

Endangered Species Act of 1973 – all Federal departments and agencies shall seek to conserve endangered species and threatened species. The purpose of the act is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved and to provide a program for the conservation of such endangered and threatened species. Implementation of Alternative Plan 5 is necessary to conserve and benefit three federally listed species:

- An Illinois subpopulation of the Hine’s Emerald Dragonfly will benefit from the removal of herbaceous (Common reed and Cattails) and woody (Multiflora rose and European buckthorn) species, in addition, the hydrological connection between the seeps that form the rivulets in LPNP feed by groundwater recharge from the PBP will be restored to a greater functionality.
- The Leafy Prairie Clover will benefit from the removal of invasive species and hydrological restoration.

- The Lakeside Daisy will benefit from the removal of invasive species.
- Alternative 5 will also benefit multiple state listed species as well, such as Blanding's Turtle.

Migratory Bird Treaty Act (1918)

The Migratory Bird Treaty Act is the domestic law that implements the United States' commitment to four international conventions for the protection of migratory birds and their habitats. The Act protects species or families of birds that live, reproduce, or migrate within or across international borders at some point during their annual life cycle. The four Migratory Bird Conventions are:

- Convention for the Protection of Migratory Birds with Great Britain on behalf of Canada (1916)
- Convention for the Protection of Migratory Birds and Game Mammals - Mexico (1936)
- Convention for the Protection of Migratory Birds and Their Environment - Japan (1972)
- Convention for the Protection of Migratory Birds and Their Environment - Union of Soviet Socialist Republics (1978)

The Mississippi Flyway

There are 4 principal North American flyways, the Atlantic, Mississippi, Central and Pacific. Except along the coasts, such as Lake Michigan, the flyway boundaries are not always sharply defined. Its eastern boundary runs along western Lake Erie and the western boundary is ambiguous, as the Mississippi Flyway merges unnoticeably into the Central Flyway. The longest migration route in the Western Hemisphere lies in the Mississippi Flyway; from the Arctic coast of Alaska to Patagonia, spring migration of some shorebird species fly this nearly 3,000 mile route twice. Parts of all four flyways merge together over Panama.

The route which includes Lockport Prairie is ideal for migratory water birds and fowl because it is uninterrupted by mountains, dotted with tens of thousands of lakes, wetlands, ponds, streams and rivers, and is well timbered in certain reaches. Lockport, Illinois is located in the Mississippi Flyway and about 200⁺ species of birds pass through this corridor annually. The Chicago Region is also one of America's most important migration routes for songbirds, with more than ~5 million individuals passing through during the migration season. Illinois and Indiana farmland consists of corn and soybean fields, which do not provide the type and variety of food and shelter required by nearly all migrating birds. In comparison, the Lockport Prairie natural area provides a variety of plant life and habitat for resting and refueling. The Lockport Prairie restoration project has great potential to provide critical migratory bird habitat. Alternative Plan 5 is in full support of the Migratory Bird Treaty Act.

EO 13186 Responsibilities of Federal Agencies to Protect Migratory Birds – Federal agencies shall restore or enhance the habitat of migratory birds and prevent or abate pollution or detrimental alteration of the environment for migratory birds. This project will restore marsh, prairie, oak savanna, and floodplain forest communities, thus providing forage and shelter for numerous migratory bird species. This project lies within a significant portion of the Mississippi Flyway sandwiched between the Des Plaines River and the coast of Lake Michigan, which particularly favors both ecological and economically valuable waterfowl species (Section 2.3.3). Alternative Plan 5 fulfills the USACE's role and responsibility by utilizing its Ecosystem Restoration Mission, authority and supporting policies to restore diverse habitats for Migratory Waterfowl and fishes that support these bird species.

Fish and Wildlife Conservation Act of 1980 – all Federal departments and agencies to the extent practicable and consistent with the agency’s authorities should promote the conservation of non-game fish, wildlife, and their habitats. Alternative Plan 5 would restore physical habitat for wildlife, which is in full support of this Act.

EO 11514 Protection and Enhancement of Environmental Quality – the Federal Government shall provide leadership in protecting and enhancing the quality of the Nation’s environment to sustain and enrich human life. Improving both the habitat and aesthetic values of the Lockport Prairie would be achieved via Alternative 5. This project would provide leadership by providing an example to other large metropolis and urban areas that highly degraded water bodies can be reclaimed for the public and nature to enhance environmental quality and recreational opportunities.

EO 11990 Protection of Wetlands – each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. Alternative 5 would restore about 239.5-acres of marsh, 9- acres of sedge meadow, 145-acres of wet prairie and 20.7-acres of floodplain forest.

EO 13112 Invasive Species – prevent the introduction of invasive species and provide for their control and to minimize associated economic, ecological, and human health impacts. Implementation of Alternative Plan 5 would remove nonnative and invasive plant species from 927.5-acres. It would also remove the effects of Common reed, Cattails and other invasive species have on the habitat of the endangered Hine’s Emerald Dragonfly.

Clean Water Act – restore the chemical and biological integrity of the Nation’s waters. Although water quality improvement is not within the USACE Mission, policy acknowledges that habitat restoration provides incidental water quality improvements most of the time. The Clean Water Act also has provisions for wetland and biological integrity protection. The No Action Alternative does not support this Act by denying opportunity to improve water quality and increase viable wetland acres. All plans support the Clean Water Act since water quality improvements would be realized through the restoration of the groundwater recharge zone within PBP by way of retaining water on-site instead of allowing it to discharge off-site through drainage tiles.

EO 13653 Preparing the United States for the Impacts of Climate Change – The impacts of climate change — including an increase in prolonged periods of excessively high temperatures, more heavy downpours, an increase in wildfires, more severe droughts, permafrost thawing, ocean acidification, and sea-level rise — are already affecting communities, natural resources, ecosystems, economies, and public health across the Nation. These impacts are often most significant for communities that already face economic or health-related challenges, and for species and habitats that are already facing other pressures. Managing these risks requires deliberate preparation, close cooperation, and coordinated planning by the Federal Government, as well as by stakeholders, to facilitate Federal, State, local, tribal, private-sector, and nonprofit-sector efforts to improve climate preparedness and resilience; help safeguard our economy, infrastructure, environment, and natural resources; and provide for the continuity of executive department and agency (agency) operations, services, and programs. The Federal Government must build on recent progress and pursue new strategies to improve the Nation's preparedness and resilience. In doing so, agencies should promote: (1) engaged and strong partnerships and information sharing at all levels of government; (2) risk-informed decision-making and the tools to facilitate it; (3) adaptive

learning, in which experiences serve as opportunities to inform and adjust future actions; and (4) preparedness planning.

Alternative 5 supports this Executive Order via the sequestration of carbon and carbon dioxide by increasing the acreage and biomass of native plant material above and below ground. Even dead plant material in the form of wood snags and debris, peat, detritus and mucks prevents carbon from entering the atmosphere. Converting homogenous spaces to diverse structures and native plants would ultimately absorb more sunlight than reflect it into the atmosphere and in turning heating up the planet.

Illinois Natural Areas Preservation Act (525 ILCS 30) – This act was passed with the intent to protect, preserve and defend natural areas and endangered species habitat for public benefit. LPNP was dedicated as an Illinois State Natural Preserve to protect the rare and sensitive plant communities. Alternative 5 would further protect and enhance the plant communities and habitat for endangered species.

Illinois Endangered Species Protection Act (520 ILCS 10/1) – The act was passed with the intent to restore and protect federal and state listed species to the point where these species would no longer need protection. LPNP occupied by three federally listed species and a variety of state listed species. Alternative 5 would further enhance and protect these rare populations of listed species.

Canal Corridor Association of the Illinois and Michigan (I and M) Canal National Corridor – The association's mission is to preserve history, protect nature and open space and create tourism along the I and M Canal Passage. Alternative 5 would protect and enhance a high quality natural area of LPNP, which is a recognized stop along the I and M canal.

Public Recognition

Public recognition means that some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

Hines's Emerald Dragonfly Recovery Plan (USFWS)

This plan supports the recovery plan for the federally endangered Hine's Emerald Dragonfly (HED). Many small subpopulations occur in Illinois and Illinois's subpopulations are known to contain the greatest amount of genetic diversity within the remaining populations world-wide. This makes these smaller somewhat isolated populations critical to conserve and increase in the number of breeding adults. LPNP's population is considered to be declining and future degradation may wipe out this population entirely, further contributing to the loss of genetic diversity for this species and reducing the chances of a long term recovery. As stated in the recovery plan for this species, removal of invasive species is an important first step in recovery of functional habitat. In addition to removal of invasive species, hydrological impairments can impact the ability of this species to successfully reproduce in their slow moving ground water feed seasonal streams. Alternative plan 5 includes measures to remove invasive species, restore higher functional hydrological connectivity between PBP and LPNP and install appropriate native plant species. These measures are expected to increase the suitability of habitat for this species and is hoped to start a full recovery of this subpopulation.

Chicago Area Paddling & Fishing

Lockport Prairie is identified on the Chicago Paddling & Fishing guide page as great place to take out from paddling along the Des Plaines River. The potential restoration of the Lockport Prairie would enhance the aesthetics and improve the paddling experience.

<http://pages.ripco.net/~jwn/sag.html>.

Des Plaines River Water Trail

A program headed by the non-profit organization Openlands has coordinated with Will and Cook Counties to create the Northeastern Illinois Water Trails. LPNP is a stopover along the Des Plaines River Water Trail.

Illinois Wildlife Protection Fund

Funding has been provided from the abovementioned fund to study the rare, state endangered Blanding's Turtle at LPNP. The fund is contributed to by public donations through a check off option on IL state income tax forms and over 500,000 people have contributed so far. The fund is a means to enhance animal habitat and protect and restore threatened and endangered species through restoration measures and further understanding of species interactions with their environment.

AllTrails, National Geographic

The walking trail at LPNP is listed as easily traversed and accessible year round on the AllTrails website hosted by National Geographic. <http://alltrails.com/parks/us/illinois/lockport-prairie-nature-preserve>.

Volunteer Stewards, Forest Preserve District of Will County

There is a small but dedicated group of local volunteers that meet once a month or more to complete small-scale management activities that include woody species removal.

Stakeholder Support

Partners in support of the Lockport Prairie Ecosystem Restoration Project and Alternative Plan 5 includes, but are not limited to: U. S. Fish and Wildlife Service, Openlands, Audubon Chicago Region, Illinois Nature Preserves Commission, Illinois Department of Natural Resources, Friends of the Forest Preserves and Friends of the Chicago River.

Lockport Township Park District

The mission of the park district is to provide park areas and recreational opportunities for the Lockport community. The park district has entered into an agreement with the state of Illinois to jointly manage the PBP. Alternative 5 would increase the wildlife viewing opportunities for the local residents.

Openlands

A non-profit organization dedicated to helping communities in northeast Illinois increase the quantity and quality of open space for public enjoyment. The organization has been instrumental in managing the number of studies undertaken to better understand the link between habitat quality and hydrology at LPNP and PBP. In addition, the organization has assisted the FPDWC in attaining the rights to PBP.

Technical Recognition

Technical recognition means that the resource qualifies as significant based on its “technical” merits, which are based on scientific knowledge or judgment of critical resource characteristics. Whether a resource is determined to be significant may of course vary based on differences across geographical areas and spatial scale. While technical significance of a resource may depend on whether a local, regional, or national perspective is undertaken, typically a watershed or larger (e.g., ecosystem, landscape, or ecoregion) context should be considered. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representation, status and trends, connectivity, limiting habitat, and biodiversity.

Scarcity is a measure of a resource’s relative abundance within a specified geographic range. Generally, scientists consider a habitat or ecosystem to be rare if it occupies a narrow geographic range (i.e., limited to a few locations) or occurs in small groupings. Unique resources, unlike any others found within a specified range, may also be considered significant, as well as resources that are threatened by interference from both human and natural causes.

Representation is a measure of a resource’s ability to exemplify the natural habitat or ecosystems within a specified range. The presence of a large number and percentage of native species, and the absence of exotic species, implies representation as does the presence of undisturbed habitat.

Status and Trend measures the relationship between previous, current and future conditions.

Connectivity is the measure of a resource’s connection to other significant natural habitats.

Limiting Habitat is the measure of resources present supporting significant species.

Technical Summary – Wildlife conservation in urban habitats is increasingly important due to current *urbanization trends*¹. Alternative Plan 5 focuses on restoring diverse habitats within the LPNP and PBP natural areas, which is *representative* of a *scarce* marsh, sedge meadow & groundwater feed streams (rivulet) and oak savanna habitats. The marsh, sedge meadow and groundwater feed rivulet portion would essentially be a mixture of open water, floating vegetation and beds of emergent hummock forming vegetation. Large areas of marsh/sedge meadows that are dominated by hummock forming vegetation is *scarce* within the Chicago Region and Illinois, with more than 90% of original wetlands having been drained for agricultural or urban development in the last two centuries. Groundwater feed fens/rivulets are even more scarce within the area, hence one reason that the Hine’s Emerald Dragonfly is listed as an endangered species. Shallow groundwater saturated soils overlaying dolomite bedrock are *scarce* within the Chicago Region and the Midwest, but what remains was saved from quarrying activities because the ability for water to remain pooled close the soil surface. Another *scarce* ecosystem that will be restored with Alternative 5 plan is prairie (wet-, wet

¹ Fernández-Juricic & Jokimäki 2001

mesic-, mesic- and dry mesic-). Although prairie was once the dominant landform type within the Midwest, their deep organic soils made it attractive for agricultural production, the Midwest has lost over 99% of the original coverage of prairie. The last *scarce* ecosystem that will be restored is the Oak savanna. It is ranked as being globally imperiled by NatureServe (accessed 2015). In terms of *connectivity*, this project adds to the increasing patches of habitat within the urbanized reaches of Northeastern Illinois, lessening the distance species have to travel over inhospitable areas of urbanized and agricultural lands. For instance, the LPNP population of Hine's Emerald Dragonfly is one of seven known populations along the Des Plaines River. These seven populations are referred to as a string of pearls. By ensuring the continued persistence of the population at LPNP, LPNP acts as a stepping stone potentially connecting other adjacent populations along Des Plaines River. Hydrologic *connectivity* is critically important for groundwater driven systems, such as the marsh/rivulet mosaic within LPNP that is fed from groundwater that is recharged from within PBP. Ensuring increased ability for surface water to infiltrate within PBP by disabling drainage tiles is important for restoring hydrological connectivity between PBP and LPNP. *Connectivity* within the site is important as well, especially between different plant communities. Hydrologic gradients (e.g., wet to wet mesic) provide the basis for a highly diverse plant community and structure, and because of the gradients, these plant communities seamlessly connect to each other. This makes it critical to restore the marsh and wet prairie habitat within PBP. Additionally, large open grassland areas are rare within the Chicago Region and by restoring large connected tracts of diverse herbaceous dominated native plant communities this provides habitat for area-sensitive grassland breeding bird species. The ability of a site to maintain a breeding population of grassland breeding birds indicates the site *represents* a large intact area dominated by herbaceous species with low to no coverage of invasive woody species. The restoration of PBP will result in suitable grassland breeding bird habitat, for such species of concern as Grasshopper sparrow, Dickcissel and the Henslow's sparrow. Many species of water fowl also require marsh for both nesting and rearing of young. Restoring high quality marsh and sedge meadow habitat would provide a critical habitat for migratory waterfowl. The proposed habitat restoration would have great potential to support several state threatened species, the Blanding's turtle and the Spotted turtle. Ultimately, the project would restore and conserve a critically imperiled subpopulation of the endangered Hine's Emerald Dragonfly and would benefit the listed Leafy Prairie Clover and Lakeside Daisy.

4.6.2 – Acceptability, Completeness, Effectiveness, and Efficiency

Acceptability, completeness, effectiveness, and efficiency are the four evaluation criteria specified that the USACE uses in the screening of alternative plans. Alternatives considered in any planning study, not just ecosystem restoration studies, should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans.

Acceptability

An ecosystem restoration plan should be acceptable to state and Federal resource agencies and local governments. There should be evidence of broad-based public consensus and support for the plan. A recommended plan must be acceptable to the non-Federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan.

The Lockport Prairie 206 study was developed in a collaborative fashion in which planning and design meetings screened and refined habitat restoration measures. The Federal, State and

local groups that participated in these activities are discussed in the previous [section](#). Alternative 1, No Action, provides no ecosystem improvements and is not acceptable to the [Federal Objective](#), the non-Federal sponsor's goals and stakeholder desires. Alternatives 2, 3, 4 and 5 are the most acceptable in terms of the Federal Objective and non-Federal sponsor/stakeholder vision for reestablishing a sustainable and viable ecosystem within the Lockport Prairie study area. Alternatives 2 thru 4 provide limited benefits but generally leave critical aquatic habitat types in a degraded state. Taking the Federal Objective, study objectives, and non-Federal sponsor/stakeholder needs into consideration, Alternative 5 provides the most diverse habitat possible and therefore would be the most acceptable.

Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Real estate, operations and maintenance, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain restoration features and an adaptive management plan has been proposed it must be accounted for in the plan.

All of the factors were considered in the development or post formulation assessment of alternative plan [costs/outputs](#), consistency with other Federal and non-Federal [Plans](#), real estate, O&M, monitoring and non-Federal sponsorship. Alternative 1 does not provide any action to restore degraded habitats and therefore is incomplete in realization of ecosystem improvements. Alternatives 2 thru 4 are incomplete in terms of restoring the entire Lockport Prairie system and are inconsistent with State and local [plans](#) for reestablishing a healthy ecosystem. Alternative 5 is the most complete in that it would address all habitat types identified as experiencing environmental degradation and in need of restorative actions. In addition, Alternative 5 provides the greatest output, fully addresses all problem issues and critical habitat within study, in the most efficient economic manner. Hence, Alternative 5 is the NER plan and is most complete for the most efficient investment of federal funds.

Effectiveness

An ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities (i.e. restore important ecosystem structure or function to some meaningful degree). The problems identified that may be addressed under this ecosystem restoration authority are impaired hydrology, invasive species, and wetland plant communities.

Alternative Plan 2: This plan includes the restoration of the hydrology of PBP through drain tile disablement, mowing of weedy herbaceous plant species, prescribed burns and native seed installation into the newly created marsh, wet prairie, wet mesic prairie and mesic prairie of PBP. This plan addresses a few of the objectives, such as increases rate of water retained and available to infiltrate to the groundwater table that will eventually discharge into LPNP (Objective #1), addresses quality and acreage of high quality plant communities (#4) through the conversion of agricultural fields into four native plant communities and increases the amount of nesting habitat for grassland bird species (#6). However, it only partially addresses restoration and sustainability of habitat for federally listed species (#5) as it does not address issues within the management units of LPNP (MU2 – 4). It would not address the invasive herbaceous and woody species within. Also, this plan would not address the erosion problem

within the oak savanna in MU2. This plan would result in a net gain of 271.4 AAHU for an AA cost of \$390,702.

Alternative Plan 3: This alternative plan is the same as Alternative Plan 2; however, this plan would also address problems within PBP (#1, #4, #6) (e.g., drain tile disablement). In addition, invasive herbaceous and woody species within MU3 of LPNP (#3) would also be addressed. A significant break point occurs between Alternative Plan 2 and Alternative Plan 3. The incremental cost/HU goes from \$1,439.48 (Alternative 2) to \$4,075.33 (Alternative 3), an increase of \$2,635.85. However, this Alternative is worth the additional cost/HU since it specifically addresses problems within areas delineated as critical habitat for federally listed species (#5), although this would only partially address the entirety of the problem, because MU4 would not be addressed with this plan. Another gap in this plan is that it would not address the erosion problem or invasive species problem within MU2. This plan would result in a net gain of 303.09 AAHU for an AA cost of \$519,768.

Alternative Plan 4: Similar to the previous plans, this plan would address problems within MU1 of PBP (#1, partially - #4, and #6) and MU3 of LPNP (partially - #3). In addition, it would also address invasive herbaceous and woody species and erosion within the oak savanna and marsh communities within MU2 of LPNP (#2). The one remaining objective, but critically important, not covered includes the habitat of federally listed species within MU4 of LPNP (#5). This plan would only partially address problems associated with presence of invasive species, quality and acreage of native plant communities and the restoration of habitat for federally listed species. This plan would result in a net gain of 309.64 AAHU for an AA cost of \$547,072.

Alternative Plan 5: Just like the previous plan, this plan would address the problems within the recharge of LPNP (MU1, Objectives #1 and #6) and erosion within MU2 (Objective #2). However, this plan would fully and completely address all objectives within the LPNP (MU2 – 4, Objectives #3 - #5). By addressing issues related to water retention and infiltration within the groundwater recharge zone, invasive species and quality of native plant communities this plan will most effectively benefit the critical habitat of the federally listed HED. This plan would result in a net gain of 340.47 AAHU for an AA cost of \$680,393. Although this plan is the most expensive best buy alternative, it most completely and effectively addresses all of the project area and the most serious problems. This plan is the chosen NER plan.

Efficiency

An ecosystem restoration plan must represent a cost-effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution.

The purpose of the Lockport Prairie project is to restore the site's hydrology, and vegetation in support of rare and critical resources, including but not limited to the endangered Hine's Emerald Dragonfly, various State Endangered Species, and critical migratory bird species. The project would remove invasive plant species and replant with native species of regional genotype. This project would also increase the acreage of US wetlands.

Seven (7) measures, including No Action, were refined to seize site specific opportunities, address Lockport Prairie's problems and were further honed by targeting the restoration objectives. Using the USACE Institute for Water Resources Planning Suite Software, 54 alternative combinations were generated from the measures. Through the CE/ICA analyses, 26

cost effective combinations were identified, which is inclusive of the five (5) Best Buy Plans. The No Action plan is always deemed cost effective and a Best Buy Plan. Only Best Buy Plans were considered for selection.

4.6.3 – Risk and Uncertainty

When the costs and outputs of alternative restoration plans are uncertain and/or there are substantive risks that outcomes will not be achieved, which may often be the case, the selection of a recommended alternative becomes more complex. It is essential to document the assumptions made and uncertainties encountered during the course of planning analyses. Restoration of some types of ecosystems may have relatively low risk. For example, removal of drainage tiles to restore hydrology to a wetland area. Other activities may have higher associated risks such as restoration of coastal marsh in an area subject to hurricanes. When identifying the NER/recommended plan, the associated risk and uncertainty of achieving the proposed level of outputs must be considered. For example, if two plans have similar outputs but one plan costs slightly more, according to cost effectiveness guidelines, the more expensive plan would be dropped from further consideration. However, it might be possible that, due to uncertainties beyond the control or knowledge of the planning team, the slightly more expensive plan will actually produce greater ecological output than originally estimated, in effect qualifying it as a cost effective plan. But without taking into account the uncertainty inherent in the estimate of outputs, that plan would have been excluded from further consideration.

Native plantings have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals and insects is a possibility and can be reasonably estimated based on baseline surveys of the existing flora and fauna. However, weather also plays a large role in the establishment success of new plantings. Periods of drought or early frost may alter the survival percentage of plantings. Although historical records can help to predict the best possible location and timing of new plantings, single unforeseen events may lead to failure. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring may be incorporated into the overall plan. In addition, climate change in the years to come may play a role in impacting the project outcome. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area; however, Lake Michigan primarily drives the weather in the Chicagoland area and may partly mitigate climate change concerns.

Complete eradication of invasive species always presents a certain level of risk and uncertainty as the chances of reinvasion are likely to occur without proper management, increasingly so when native species have not yet established. Changes in nutrient cycling processes and soil chemistry (due to impaired hydrology and prolonged invasive species establishment) further increases uncertainty with the eradication of invasive species. Measures that prevent further degradation to soils and measures that alleviate impaired hydrology can reduce the invasibility of the ecosystem and should lessen the risk and uncertainty associated with invasive species removal.

The presence of three federally endangered species presents a certain level of risk and uncertainty as special care must be taken to avoid impacts to these species during construction. The three federally endangered species known to inhabit the study area are the Hine's Emerald Dragonfly, Leafy Prairie Clover, and Lakeside Daisy. If a plan is selected to be implemented, USACE would continue coordination with the USFWS during the design and construction

phases in order to mitigate any risks towards these three federally endangered species, as well as for any state listed species.

4.7 – Selection of the National Ecosystem Restoration Plan

When selecting a single alternative plan for recommendation from those that have been considered, the criteria used to select the NER plan include all the evaluation criteria discussed above. Selecting the NER plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness. Additional factors to consider include the following items.

Partnership Context

This restoration project was planned in cooperation with the FPDWC. This restoration project makes a significant contribution to regional, national, and international programs that include the North American Waterfowl Management Plan. This plan included an opportunity for open comment to ensure all stakeholder parties have had equal contribution.

Reasonableness of Costs

All costs associated with a plan were considered and tests of cost effectiveness and incremental cost analysis have been satisfied for the alternatives analyzed. The cost estimates were based on current ecosystem restoration projects of the like that are in construction.

Having established confidence in the estimated implementation costs, the remaining test of reasonableness is to assess the value of the resource to be improved based on the cost to implement the improvement. The importance of the Lockport Prairie in terms of habitat, and human uses has been documented through numerous sources.

In terms of non-monetary values, the ecosystem of the Lockport Prairie and its importance to the region is emphasized by the institutional and technical significance of providing necessary migratory bird habitat within the Central Flyway, which is recognized as Nationally Significant by the Audubon Society. Observation of bird and plant ecology in the immediate area classified this site as critical habitat for rare and conservative flora as well as resident and migratory birds. In addition, the project provides critical habitat for the federally listed Hine's Emerald Dragonfly, Leafy Prairie Clover and Lakeside Daisy. These analyses suggest that restoration and preservation measures are cost effective.

The NER Plan

The plan that reasonably maximizes net national ecosystem restoration benefits, consistent with the Federal objective, is identified as the NER plan. Thus, the plan that maximizes net NER benefits and has shown great merit in the trade-off analysis is Alternative 5 (Figure 11). The NER Plan is considered as the Preferred Plan for direct, indirect, and cumulative effects assessment under NEPA in the following Chapter. The plan would restore 927.5-acres result in a net increase in 340.47 average annual habitat units with a total construction cost of \$ [REDACTED].

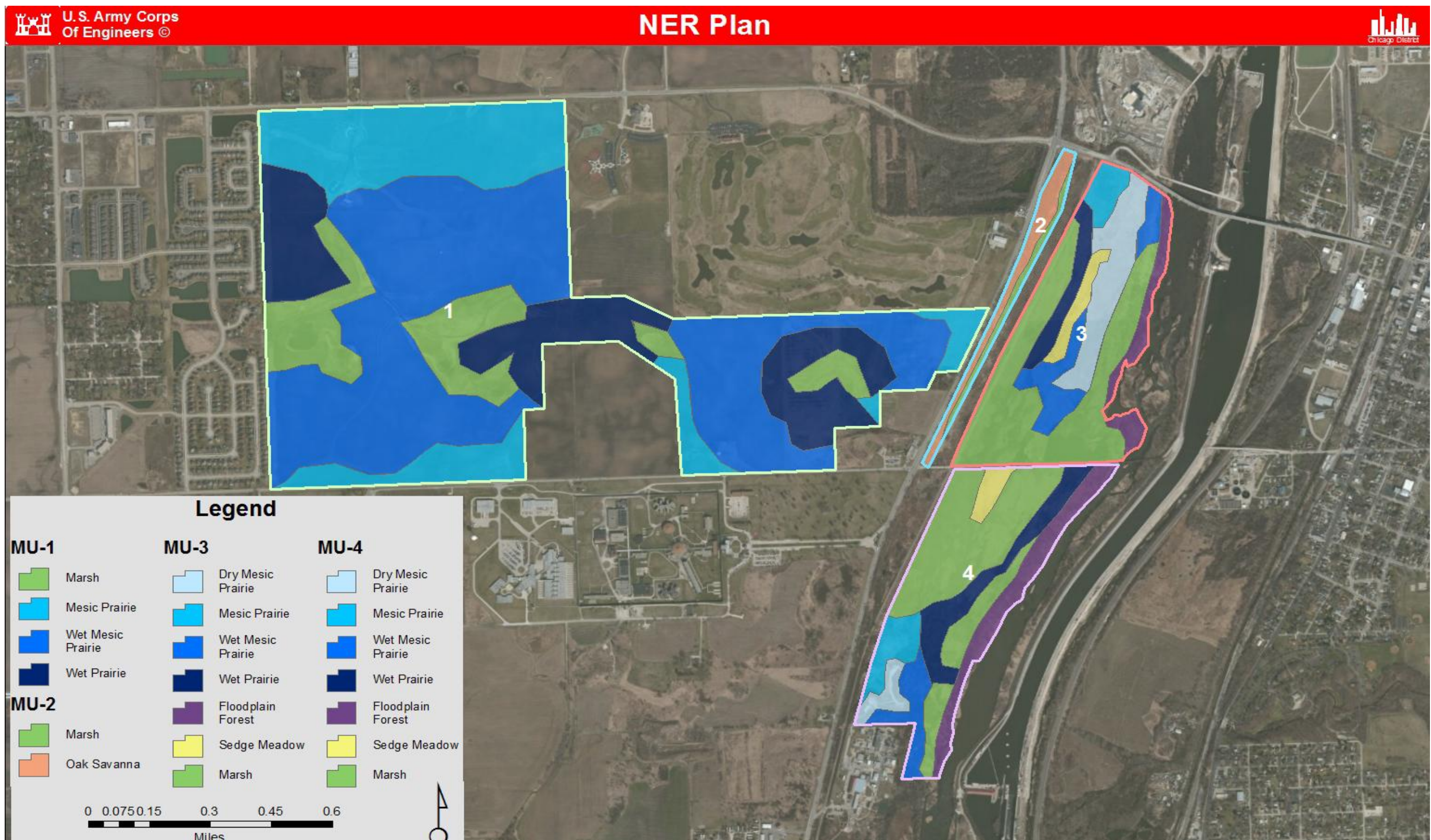


Figure 11. Alternative 5, National Ecosystem Restoration (NER) Plan

Chapter 5 – Environmental Assessment

This chapter involves identification of the environmental effects to existing conditions resulting from implementation of the NER/Preferred Plan.

5.1 – Need & Purpose

Currently, the majority of habitat (i.e., community) types within Lockport Prairie study area (marsh, sedge meadow, wet prairie, wet mesic prairie, oak savanna and floodplain forest) have been compromised to the point where they are unable to maintain their historic structure and support high quality plant and animal communities. The resources lost in the habitat structure have caused a marked decline in both species richness and abundance of native animal assemblages, especially the endangered Hine’s Emerald Dragonfly. Based on site inventory and characterization by the USACE, a set of Problems and Opportunities were developed by the study team, non-Federal Sponsors and supporting stakeholders. The Problems and Opportunities drive the need for action, which is summarized as the historic loss of significant endangered species, and migratory bird and wildlife habitats. The purpose of this feasibility study and integrated environmental assessment is to identify the most environmentally beneficial, cost effective and publicly supported habitat restoration project that would restore resources lost from the past disturbances that occurred within the study area.

5.2 – Alternatives Considered

Section 4.1 provides discussion on the suite of measures that were developed to address study problems and meeting objectives. These measures that were processed through the IWR Planning Suite program to generate cost effective plans. The cost effective and incremental cost analysis takes implementation and real estate costs and ecosystem outputs into consideration. Ecosystem outputs were measured via the Floristic Quality Index (FQA). Five (5) alternative plans, including the No Action Plan, were deemed best case scenarios for project implementation. Alternative 5 was selected as the National Ecosystem Restoration (NER) Plan, which for the purposes of this Environmental Assessment is termed the Preferred Plan. Rationale for selecting the NER/Preferred Plan is presented in Section 4.6 and 4.7.

- Alternative Plan 1: (No Action Plan Future) Without-Project Conditions (see Section 2.5.2)
- Alternative Plan 2: MU-1 (see figure 7 for map of management units): Full restoration of hydrology through disablement of drain tiles, invasive species removal, prescription burning and native plant installation
- Alternative Plan 3: MU-1: Full restoration of hydrology through disablement of drain tiles, invasive species removal, prescription burning and native plant installation & MU-3: Full restoration by removal of invasive herbaceous and shrub, prescription burning and native plant installation
- Alternative Plan 4: MU-1: Full restoration of hydrology through disablement of drain tiles, invasive species removal, prescription burning and native plant installation & MU-2 & MU-3: Full restoration by removal of invasive herbaceous and shrub, prescription burning and native plant installation

- Alternative Plan 5: MU-1: Full restoration of hydrology through disablement of drain tiles, invasive species removal, prescription burning and native plant installation & MU-2 & MU-3 & MU-4: Full restoration by removal of invasive herbaceous and shrub, prescription burning and native plant installation

5.3 – The Affected Environment

A detailed description of the affected environment can be found in Chapter 2 – Inventory & Forecasting. Based on data collection, analysis, and modeling conducted under this feasibility study and coordination with Federal, State and local governmental agencies and published studies by academia, it was determined that the physical, chemical and biological conditions of the study area are in a state of degradation. As a result, most community types are dominated by species that are tolerant to habitat loss, anthropogenic disturbance and altered hydrological conditions. There is also grave concern for the continued persistence of the federally listed Hine’s Emerald Dragonfly population within the LPNP marsh/sedge meadow habitat as a result of continuing alterations to the groundwater recharge zone within PBP. Slight improvements in some vegetation patches that have occurred through past shrub removal are not enough for native plant and animal communities to reestablish, resulting in missing critical structural habitat components. The No Action Alternative conditions are synonymous with the Future Without-Project Conditions, which are presented in Section 2.6.

5.4 – Direct & Indirect Effects of the Preferred Plan

In addition to the effects discussed in the following sections, a 404(b)(1) analysis is provided in **Appendix A**. This analysis further documents whether or not there are effects to the aquatic environment resulting from construction activities as guided by the Clean Water Act.

5.4.1 – Physical Resources

Climate

The NER/Preferred Plan would have incidental benefits to climate change via the long term sequestration of carbon. This would happen via the reestablishment of native plant communities and stored organic carbon in soils and sediments. Short term affects from petroleum fueled machines are considered negligible based on the long term benefits of carbon sequestration.

Air Quality

The local air quality in Lockport, Will County, IL is considered ‘non-attainment’ under the Clean Air Act for 8-hour ozone and sulfur dioxide. Once implemented, the project itself will be neutral in terms of air quality, with no features that either emit or sequester air pollutants to a large degree. This project is a *deminimis* exemption. During the project construction, heavy equipment would cause minor, temporary air quality impacts, however all equipment will be in compliance with current air quality control requirements for diesel exhaust, fuels, and similar requirements. Prescription burns release minor amounts of particulates and are not considered

a significant source of air pollution. Current levels of prescription burns will not increase under project or O and M.

Soils

Soils within LPNP are predominantly Romeo, an alluvial soil shallow to bedrock. Additionally, the majority of soils within LPNP and PBP are hydric or have hydric inclusions, and are underlain by fractured dolomitic limestone bedrock. Soil quality, defined as the ability to sustain diverse native plant communities, is intact within LPNP. This is the result of low levels of human activities within the preserve over the last 100 years. Soil quality within PBP has been impacted by many years of agricultural production that have resulted in a highly disturbed upper 12 inches of soil overlaying a lightly compacted layer. The NER/Preferred Plan would remove agricultural activities, address erosion and result in a more stable soil structure. Soils would be minimally disturbed by the implementation of the proposed restoration measures. Disturbance to soils would be limited to installation of small water control structures designed to disable drain tiles resulting in no movement of soil from or around the project site. There would be no adverse effects resulting from implementation of the NER/Preferred Plan.

Water Quality

The NER/Preferred Plan would have incidental water quality benefits through the removal of invasive shrub species, that contribute to erosion, and introduction and establishment of native herbaceous plant species. Water quality is also expected to improve downstream of PBP when drain tiles are disabled and more rainwater is retained and infiltrated to the groundwater on-site. There is no expected measurable effect to water quality within the adjacent Des Plaines River. Short term affects are expected to be negligible and would be mitigated through installation of erosion control blankets on any bare soil areas and installation of fast germinating and growing cover crop followed by slower germinating native plants. Long term, adverse effects to water quality stemming from construction activities is not anticipated.

Geology

The ecology of the study area is significantly influenced by this glaciofluvial formed landscape, which deposited a blanket of unsorted debris over most of the region that includes clay, sand, gravel, and boulders, collectively called glacial till. The study area was a glacial sluice way for discharge water from a once retreating Lake Chicago, which is now Lake Michigan. The NER/Preferred Plan would not disturb any geologic features or displace glacial materials present, there would be no adverse effects resulting from implementation of the NER/Preferred Plan.

Topography

The topography within the study area is diverse due to the historically intense geologic activity. The NER/Preferred Plan would not disturb any natural topography currently present. There would be no adverse effects resulting from implementation of the NER/Preferred Plan.

Surface and Groundwater Hydrology

The hydrology within the study area is quite intricate due to the historically intense geologic activity. Hydrologic modifications to the system to achieve ecosystem restoration include

disablement of drain tiles within PBP and slowing down surface runoff through the oak savanna in LPNP. The disablement of drain tiles within PBP would increase the amount of water available to infiltrate into the groundwater table and is expected to aid in the restoration and preservation of Hine's Emerald Dragonfly critical habitat. Stream hydraulics within the small rivulets would be restored by allowing more water to infiltrate to the groundwater table within the recharge zone, thereby increasing the chances of longer wet periods and shorter dry periods during the growing season. This will allow for the groundwater source to drive stream hydraulics, which is the natural condition that the Hine's Emerald Dragonfly is adapted to. Ultimately, there would be no adverse effects to study area surface and groundwater hydrology resulting from the implementation of the NER/Preferred Plan.

Hazardous, Toxic & Radioactive Waste (HTRW)

The NER/Preferred Plan would not affect or be affected by HTRW materials. Non-HTRW materials will be disposed of as recommended in the HTRW assessment (section 2.2.7) for purposes of installing and establishing high quality native plant communities.

5.4.2 – Ecological Resources

Wildlife

Macroinvertebrates – Currently, significant species richness and abundance of macroinvertebrates have been found within the study area, which was expected due to the status of the remnant plant communities. The removal of invasive plant species is expected to benefit many prairie specific macroinvertebrate species. There would be no adverse effects to study area macroinvertebrates resulting from the implementation of the NER/Preferred Plan.

The most important of all macroinvertebrates for this study is the Hine's Emerald Dragonfly, which only occurs in the rivulets that are fed by discharging groundwater flowing through the a native prairie/wetland that also have the *Cambarus diogenes* (crayfish) as in LPNP. The activities planned to restore these rivulets is imperative to conserve the Hine's Emerald Dragonfly population in LPNP. The first activity would be to increase the ability of the groundwater recharge zone to retain and infiltrate greater quantities of water. Groundwater discharge has been decreasing in quantity and length of discharge through the growing season. During the drain tile disablement activities within PBP that would ensure a more stable hydroperiod for rivulets, invasive plant species would be removed and native wetland plants installed in the wetland areas with LPNP. Selective herbicides and hand applications for all treatment activities would limit any contact between workers or worker's activities and larvae and adults of the Hine's Emerald Dragonfly. It is possible that vibrations from workers walking near the areas of larvae may cause larvae to release and drift, but this is temporary and larvae would resume normal function once workers have passed. There is also periodic trains that travel through the site that also cause temporary vibrations. The Hines's Emerald Dragonfly seems to have coped with this disturbance in the same way as described by vibrations caused by people walking past. Coordination and consultation with the USFWS would continue throughout construction and establishment of the restoration project. The NER/Preferred Plan would not have adverse effects on the Hine's Emerald Dragonfly within LPNP.

In addition, the highly diverse ant community is expected to benefit from the removal of invasive species and will not be adversely affected from the proposed restoration measures.

Resident/Migratory Birds – The study area is located within the eastern boundary portion of the Mississippi Flyway, which is nationally recognized as an important route for many migratory and resident birds. The NER/Preferred Plan recommends the removal of invasive plant species and the establishment of native plants, which provide habitat for organisms and plant structure that support migratory birds and in particular, water birds (herons, mergansers, grebes, etc.). Activities during the first year of construction may make the LPNP unsuitable for wetland and grassland breeding birds because of the amount of hand work that would be required to remove invasive herbaceous plants and shrubs, which would have short term effects of forcing birds to find other resting and foraging areas; however, this doesn't compare to the positive effects of restoring about 927-acres of high quality marsh and grassland habitat. Based on this, there would be no long term adverse effects to migratory and residential birds within study area or the surrounding area resulting from implementation of the NER/Preferred Plan. Bird species effects resulting from the implementation of the NER/Preferred Plan are considered to be beneficial.

Mammals – Currently, only those mammal species indicative of urban life are present within the study area. Based on this, and the activities of restoring native plant communities, there would be no adverse effects to small or large mammals within the study area resulting from implementation of the NER/Preferred Plan.

Plant Communities – Currently there is little coverage of native plant species within PBP. Plant species identified from LPNP communities are generally comprised of a mix of native, including patches of the federally listed Leafy Prairie Clover and Lakeside Daisy, non-native, and Eurasian species. The NER/Preferred Plan recommends the removal of invasive plants and Eurasian species and the reestablishment of several different native plant communities. While invasive and non-native trees will be removed, remnant patches of high quality plant community would be preserved and avoided. Based on this, there would be no adverse effects to plant communities within the study area or the surrounding areas resulting from implementation of the NER/Preferred Plan. Plant community effects resulting from the implementation of the NER/Preferred Plan are considered to be beneficial.

Threatened & Endangered Species

Federal – The three federally listed species known to inhabit the study area include the Hine's Emerald Dragonfly, Leafy Prairie Clover and Lakeside Daisy. Threats to Hine's Emerald Dragonfly include habitat loss, habitat degradation, habitat succession, and disruption of ecological and hydrological processes. The proposed project would restore and preserve dragonfly habitat within the study area and would greatly benefit this important population of the species. The removal of invasive plant species from areas known to host the Leafy Prairie Clover and the Lakeside Daisy would benefit the long term success of these species within the study area. Recommendations from the USFWS will be used during construction to minimize disturbance to the 3 federally listed species. For these reasons, we conclude the results from implementation of the NER/Preferred Plan have no adverse affects on the listed species or proposed or designated critical habitat.

State – There are at least eleven (11) species that are listed as threatened or endangered in Illinois that have been observed at or near the study area, they include 7 bird species (e.g., King Rail) and 4 reptile species (e.g., Blanding's Turtle). Based on the habitats used by these

species and the type of activities that would occur should the NER/Preferred Plan be implemented, there would be no adverse effects to state threatened and endangered species within the study area.

5.4.3 – Cultural Resources

Cultural & Social Properties

Available facilities include designated areas for hiking, canoeing, picnicking, and fishing. Also, the Lockport Prairie is a popular birding destination. Temporary closure to the public during construction will be necessary; however, the short term period of no birdwatching would be outweighed by an increase in grassland breeding bird habitat within PBP.

Archaeological & Historical Properties

The NER/ Preferred Plan would have no adverse impacts on archaeological or historic properties. The project would involve ground disturbance only in areas already disturbed by tilling and disking such as the disablement of the drain tiles in PBP; therefore no impacts to archaeological or historic properties would result. The project would have no impact on the historic Division Street Bridge, or on its visual setting. The project would have no impact on structures or visual setting of the I&M Canal and Heritage Corridor; the CSSC and San-Ship Canal Historic District; or the Illinois Waterway. The Illinois Historic Preservation Agency (SHPO) was consulted in a letter dated 21 December 2006 and has concurred with this determination in a letter dated 9 January 2007. In the event of an accidental discovery of cultural resources, the Illinois State Historic Preservation Agency will be contacted and consultations will take place.

Land Use History

The NER/ Preferred Plan will not have any adverse impacts on the area's historical land uses. Land use within the study area, specifically PBP, would change from agricultural activities to a high quality native plant community, but this is not consider to be an adverse affect via the implementation of the Preferred Plan/NER Plan. The modern agricultural practices that take place within PBP are considered to be a hindrance to the recovery of an endangered species. The conversion of the land use from modern agricultural practices to the original grassland matrix is considered beneficial to the area.

Social Properties

The NER/ Preferred Plan will not have any adverse impacts on the area's social properties. Aesthetic and open space improvements resulting from implementation of the NER/ Preferred Plan may positive effects on adjacent parks and neighborhoods.

5.4.4 – 17 Points of Environmental Quality

The 17 points of Environmental Quality are defined by Section 122 of Rivers, Harbors & Flood Control Act of 1970 (P.L. 91-611). Effects to these points are discussed as follows:

Noise: Under any of the alternative plans there would be elevated, but intermittent, levels of noise from construction machinery during the first 1 to 2 years of the restoration project. This is a temporary and intermittent affect that would cease as soon as tree removal and drain tile disablement is complete.

Displacement of People: Any of the alternative plans would not displace local residents within the township of the study area since only open space parcels are proposed for restoration.

Aesthetic Values: Any of the alternative plans would not reduce the aesthetic values of the study area, but greatly enhance aesthetics resulting from shifting the farm field of PBP into a verdant diverse mixture of native grasses and flowers.

Community Cohesion: Any of the alternative plans would not disrupt community cohesion, but provide restored open space for community activities.

Desirable Community Growth: Any of the alternative plans would not adversely affect community growth based on project restoration measures.

Desirable Regional Growth: Any of the alternative plans would not adversely or beneficially affect regional growth.

Tax Revenues: Any of the alternative plans would not adversely or beneficially affect tax revenues.

Property Values: Any of the alternative plans would not have adverse affects on property values, but has the potential to increase surrounding land values since the aesthetics would improve to do project restoration measures.

Public Facilities: Any of the alternative plans would not adversely affect public facilities, but would provide a more natural and healthy open space and provide high quality wildlife viewing opportunities.

Public Services: Any of the alternative plans would not adversely or beneficially affect public services.

Employment: Any of the alternative plans would not adversely affect employment and would temporarily increase employment during construction activities.

Business and Industrial Activity: Any of the alternative plans would not adversely or beneficially affect local commerce.

Displacement of Farms: The Preferred Plan/NER Plan would adversely affect farmland since restoration of PBP would eliminate modern row crop production from this study area. However, native grasslands are frequently managed by periodic mowing and haying, which could be offered as a contract for hay production to local farmers. PBP is not considered prime or important farmlands defined by the Farmland Protection Policy Act of 1981.

Man-made Resources: Any of the alternative plans would not adversely or beneficially affect man-made resources.

Natural Resources: The No Action Alternative allows for the continued degradation of native species, rare communities, and significant habitats. The proposed project would not adversely affect natural resources, but improve them greatly.

Air: Any of the alternative plans would not adversely affect long term air quality since machinery for construction activities would be limited to several months of total time and levels of prescription burning will not increase. These activities would be unnoticeable compared to current traffic within the area and surrounding trucking routes within the immediate project area.

Water: Any of the alternative plans would not adversely affect water quality, but incidentally improve it in both the PBP watershed and rivulets for the Hine's Emerald Dragonfly. Additionally, the results of the 404(b)(1) analysis demonstrates no impacts to wetland resources.

5.5 – Cumulative Effects

Consideration of cumulative effects requires a broader perspective than examining just the direct and indirect effects of a proposed action. It requires that reasonably foreseeable future impacts be assessed in the context of past and present effects to important resources. Often it requires consideration of a larger geographic area than just the immediate “project” area. One of the most important aspects of cumulative effects assessment is that it requires consideration of how actions by others (including those actions completely unrelated to the proposed action) have and will affect the same resources. In assessing cumulative effects, the key determinant of importance or significance is whether the incremental effect of the proposed action will alter the sustainability of resources when added to other present and reasonably foreseeable future actions. Cumulative environmental effects for the proposed ecosystem restoration project were assessed in accordance with guidance provided by the Council on Environmental Quality (CEQ) and U.S. Environmental Protection Agency (USEPA 315-R-99-002). This guidance provides an eleven-step process for identifying and evaluating cumulative effects in NEPA analyses.

5.5.1 – Scope of Cumulative Effects Analysis

Through this environmental assessment, the cumulative effects issues and assessment goals are established, the spatial and temporal boundaries are determined, and the reasonably foreseeable future actions are identified. Cumulative effects are assessed to determine if the sustainability of any of the resources is adversely affected with the goal of determining the incremental impact to key resources that would occur should the proposal be permitted.

The spatial boundary for the assessment has been broadened to consider effects beyond the footprint of Lockport Prairie. The spatial boundary being considered is normally in the general area of the proposed ecological restoration; however, this area may be expanded on a case-by-case basis if some particular resource condition necessitates broadening the boundary.

Three temporal boundaries were considered:

- Past –1830s because this is the approximate time that the landscape was in its natural state, which included, marsh, sedge meadow & rivulet, wet prairie, oak savanna, and floodplain forest.

- Present – 2015 when the decision is being made on the most beneficial ecological restoration
- Future – 2065, the year used for determining project life end, although the ecological restoration should last until a geologic event disturbs the area.

Projecting the reasonably foreseeable future actions is difficult. The proposed action (ecosystem restoration) is reasonably foreseeable; however, the actions by others that may affect the same resources are not as clear. Projections of those actions must rely on judgment as to what are reasonable based on existing trends and where available, projections from qualified sources. Reasonably foreseeable does not include unfounded or speculative projections.

- Stable growth in both population and water consumption near the study area
- Sowing of native plants to return plant communities across the landscape
- Continued increase in tourism/recreation in the open spaces of the region
- Continued, but slowed urban development near the study area
- Continued application of environmental requirements such as those under the Clean Water Act
- Implementation of various programs and projects to deal with runoff and waste water pollution and to restore degraded environments
- Community will increasingly value not only the open space but the biodiversity as well
- Improvement to nearby natural areas surrounding the study area
- Continued pressures and threats to the Hine's Emerald Dragonfly's populations within Illinois

5.5.2 – Cumulative Effects on Resources

The plan formulation process took into account existing and planned projects, studies and known ecological restoration projects in the study area. Pertinent projects were identified in Section 1.5 that have the potential for affecting or being affected by a potential Lockport Prairie restoration project. Prior studies and reports, also listed in Section 1.5 were reviewed to ensure that the modeled conditions are the best possible representation of actual conditions. The Technical Recognition Section (Section 4.6.1 Significance of Ecosystem Outputs) also takes existing and future habitat restoration projects into consideration for assessing project effects. Finally, the study team also worked with Federal, State, and local agencies to coordinate ongoing planning to address local environmental and infrastructure issues.

Physical Resources

The past has brought alteration to the physical resources of the study area. Portions of the site's geology, soils, topography, hydrology, hydrogeomorphology, and hydraulics have all been modified to during the construction of the Chicago Area Waterway System (I and M Canal), modern farming techniques and quarrying activities. Also, natural processes that drive diverse native ecosystems such as fire and Des Plaines River migration have ceased within the study area. Even though there is moderate urban development within the watershed, moderate alterations within a system such as the study area has resulted in significant changes in hydrological regimes. It is reasonably foreseeable that small projects within the study area for ecological restoration purposes would occur. Best management practices and water reclamation systems are important but not numerous and big enough to remove impacts to PBP and the rivulets within LPNP. Given the past, current and future condition of the study area's

physical resources, the implementation of this ecosystem restoration coupled with potential future infrastructure projects would have important positive effects, but are not considered cumulatively significant. There are no irrecoverable loss of resources identified in terms of geology, air, soils, substrates, topography, hydrology, water quality and fluvial geomorphology due to implementation of the NER/ Preferred Plan in the context of study past and future activities. Cumulative beneficial effects to the study area's physical resources are anticipated in terms of geologic features and deposits, soils, substrates, hydrology, hydraulics, and water quality.

Biological Resources

The ecosystem integrity within Lockport Prairie has had significant impacts as a result of previous physical and biological resource alterations. The area was intensely geologically active, which drove an immensely diverse ecosystem complex. This complex was inclusive of now rare and interesting habits such as the sedge meadow & rivulets and dolomite prairie, which provides critical life requisites for the endangered Hine's Emerald Dragonfly. All of the resulting plant communities have since been degraded to some degree via the physical alterations noted above compounded by physical removal of native vegetation and the infestation by non-native weeds within PBP. It is reasonably foreseeable that small projects within the study area for ecological restoration purposes would occur. Small patches of non-native species would be typically removed and replanted with natives, but the larger surrounding areas would maintain invasive species populations and a high potential for reinvasion and degradation of these small patches without large management investments. Considering these past, current and future conditions of the study area, the implementation of the NER/ Preferred Plan is minor in terms of the vast array and quantity of significant effects caused by past industry and urbanization; however, it is instrumental in beginning to address the human induced problems the area suffers and to save an endangered species population. Therefore, there are no irrecoverable losses of resources identified in terms of plant, insect, fish, amphibian, reptile, bird, and mammal taxa or to their habitats they occupy due to implementation of the NER/ Preferred Plan. Cumulative beneficial effects to the Lockport Prairie biological resources are anticipated in terms of plants and wildlife and their preferred habitats.

Cultural Resources

The study area has few cultural and historic significant places or structures, and the Preferred Plan/NER Plan would not affect any of these directly or indirectly. Therefore, there are no irrecoverable losses of resources identified in terms of cultural, archaeological, or social aspects due to implementation of the Preferred Plan/NER Plan. Cumulative effects to area cultural resources are considered to be neutral.

5.5.3 – Cumulative Effects Summary

The overall cumulative effects of the Lockport Prairie habitat restoration project are considered to be beneficial environmentally, socially and economically. Irreversible and irretrievable commitment of resources were not identified from implementation of the proposed action; NEPA 1502.16 (102(2)(C)(v)). Relationships between local short-term uses of man's environment and maintenance and enhancement of long term productivity would be swayed towards ecological recovery of Lockport Prairie; NEPA 1502.16 (102(2)(C)(iv)). No adverse

environmental effects which cannot be avoided were identified should the proposal be implemented; NEPA 1502.16 (102(2)(C)(ii)).

5.6 – Compliance with Environmental Statutes

The Preferred Plan presented in this integrated Environmental Assessment are in compliance with appropriate statutes, executive orders and Corps regulations including the Natural Historic Preservation Act of 1966; the Endangered Species Act of 1973; the Fish and Wildlife Coordination Act; Executive Order 12898 (environmental justice); Executive Order 11990 (protection of wetlands); Executive Order 11988 (floodplain management); and the Rivers and Harbors Act of 1899. The potential project is in compliance with the Clean Air Act; the Clean Water Act, and the National Environmental Policy Act of 1969. There were no adverse environmental effects identified which cannot be avoided should the proposal be implemented. This proposal reverses some of the adverse affects of some previous local and short-term uses of the environment, while maintenance and restoring the long term productivity of a portion of the Mississippi Flyway. There have been no irreversible and irretrievable commitments of resources identified resulting from the proposed action should it be implemented. The proposed project supports land-use plans identified in the Prairie Bluff Preserve Restoration and Development Plan (Forest Preserve District of Will County, 2008) in terms of natural area restoration.

An investigation into the characteristics of the farmland in PBP included consulting the map of prime farmland or important farmland within the state of Illinois created and published in October 2009 by the Natural Resources Conservation Service. No prime or important farmland is located in PBP.

Environmental Justice EO 12898

The Preferred Plan would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations. Executive Order 12898 (environmental justice) requires that, to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

A database search of the EPA EJView mapping tool (Accessed 27 October 2014), revealed that within the greater Lockport, Illinois area in which the Lockport Prairie study area occurs, there are not Environmental Justice issues to be concerned with. Since the overall project is considered ecosystem restoration and will only benefit the surrounding environment and communities, no adverse effects to any low income populations and/or minority populations are expected.

Clean Air Act

The local air quality in Chicago Metropolitan Region are considered 'non-attainment' under the Clean Air Act for ozone, particulates (PM-10 and PM-2.5), and lead. The project is within the non-attainment zone. Once implemented, the project itself will be neutral in terms of air quality, with no features that either emit or sequester air pollutants to a large degree. During the project construction, heavy equipment and prescription burns would cause minor, temporary air quality impacts, however all equipment will be in compliance with current air quality control requirements for diesel exhaust, fuels, and similar requirements and levels of current prescription burns will not increase. A general conformity analysis was not conducted due to the short and temporary nature of any air quality impacts.

Section 401 & 404 of the Clean Water Act

A Section 404(b)(1) analysis was completed for the preferred plan and is located in Appendix G. Features addressed by the 404 include the disablement of drainage tiles within PBP to create wetland habitat and increase ability of water to be retained and infiltrate to aquifer. No long-term, adverse effects were determined. Since project activities under the jurisdiction of Section 401 are none, no permit for Section 401 Water Certification would be sought.

USFWS Coordination

Coordination with between the Chicago District and Region 3 US Fish & Wildlife Services began in 2002 with informal meetings discussing problems on the site and potential restoration actions. Our coordination has been completed for this phase of the project. The U S. Fish and Wildlife has completed their review of the proposed project and supports the proposed restoration measures. The following is the summary of their findings from their February 11, 2015 letter:

"We strongly support the removal of invasive plant species and hydrological restoration for the important habitat within LPNP and provided by PBP. We encourage the consideration of the above mentioned recommendations. If changes or modifications to the plan occur during design, these should be provided to our office for review and comment. We support the proposed ecological restoration of LPNP and PBP including the above measures to identify and protect the HED, leafy prairie clover, Lakeside daisy, and the eastern prairie fringed orchid."

State of Illinois Historic Preservation Act

Coordination with the Illinois Historic Preservation Agency (IHPA) commenced with a project scoping letter dated 21 December 2006. In a letter 09 January 2007, the IHPA informed USACE that if any cultural or archaeological material is discovered during earthwork in already disturbed area, activities should cease and the SHPO would be notified.

Tribal Coordination

USACE is required to perform tribal coordination and scoping letters were sent to the 12 tribes listed in Appendix G. We received no response and our determination that it's not likely any tribal lands will be impacted by the implementation of the Preferred Plan/NER Plan.

FAA Wildlife Hazard Assessment and Coordination

Three airports were identified to be within 5 and 10 miles of the study area. Specifically, LPNP and PBP are within the 10,000 foot separation zone of Lewis University Airport. In addition, Joliet Park District Airport and Bollingbrook's Clow International Airport are within 6.3 miles and 7.4 miles, respectively, of the study area. An initial analysis of hazardous wildlife was performed. It was determined that four groups of species (cranes, shorebirds, American Kestrel and Meadow Larks) would likely respond positively to proposed restoration at PBP and LPNP; however, the relative abundance of these species within the flight corridor of the identified airports is not expected to significantly change. The only crane species is expected to respond favorably to restoration actions is the Sandhill Crane. Large flocks are mostly attracted to large open agricultural fields, and less so to newly restored grasslands as would be the case at PBP and LPNP. Coordination with the FAA/USDA was initiated in 2009 by the FPDWC and a follow up e-mail was sent in May 2015. Documentation of the wildlife hazard assessment as well as coordination between the FPDWC and USDA wildlife officials can be found in Appendix G-Compliance. Results of wildlife hazard assessment and coordination with FAA/USDA ensures this project is in compliance with all recommendations.

Finding of No Significant Impact (FONSI)

The draft Finding of No Significant Impact (FONSI) maybe found in Appendix G. An Environmental Assessment was completed for the proposed habitat restoration within the Lockport Prairie study area near Lockport, Illinois. The Environmental Assessment has concluded that there would be no adverse affects resulting from implementation of the NER/Preferred Plan and that an Environmental Impact Statement is not warranted for this project. A 30-day Public Review period will be held from 04 August 2015 to __ __ 2015, and any comments received would be incorporated document if necessary. The NEPA document and supporting appendices were placed on the Chicago District's Civil Works webpage for maximum distribution.

Chapter 6 – Plan Implementation

This chapter outlines details for implementing the Preferred Plan/NER Plan. Plan implementation details include sequencing, environmental assessment findings, mitigation requirements, permit requirements, agency and stakeholder views, project schedule, total project costs and cost sharing requirements.

6.1 – Plan Authorization

Study and implementation authorization by Congress is provided by the Aquatic Ecosystem Restoration Section 206 (*Water Resource Development Act, 1996 P.L. 104-303.SEC. 206. As amended. 33 US Code § 2330*). Following completion and approval of this feasibility study, USACE implementing guidance allows the Chicago District to enter into a Project Partnership Agreement for continued design, plans and specifications, construction and subsequent monitoring.

6.2 – Implementation & Sequencing

The National Ecosystem Restoration (NER) Plan is the recommended plan, which is Alternative 5. This alternative consists of the following measures: Disablement of drain tiles (MU-1), removal of invasive tree/shrub species (MU-2, MU-3 and MU-4), eroded area (MU-2), removal of herbaceous invasive plants (MU-1, MU-2, MU-3 and MU-4), selective mowing (MU-1), prescription burns (MU-1, MU-2, MU-3 and MU-4) and installation of native plants (MU-1, MU-2, MU-3 and MU-4). The implementation of all of these measures would restore marsh, sedge meadow, wet prairie, wet mesic prairie, mesic prairie, dry mesic prairie, oak savanna and floodplain forest communities within Lockport Prairie. All measures culminating in the restoration and preservation of a population of Hine’s Emerald Dragonfly. The implementation of these features is generally described as follows and according to the measures descriptions in [Section 4.1](#). Much more detail would be added to the plan during the implementation phase, for example, specifying spatial distribution of native plugs within a given zone and species clumping, planting centers, temporary predator controls, and establishment activities. General construction activities and sequencing would include:

1) Site Preparation – The first task would be to install safety fencing, signage and other safety features in order to keep the public out of the site during heavy construction. Staging areas and access roads would be demarcated.

2) Invasive Species Eradication – All invasive plant species would be physically and chemically eradicated from the problem zones within each habitat to be restored. All woody invasive species removed would be cut flush to ground and chipped into small pieces and removed from site, except those that would remain within the area to produce decaying woody debris.

3) Drain tile disablement – Installation of specifically placed water control valves will be completed first year of contract in order to allow the water to start to backup in the tiles and the hydrology of the PBP to stabilize of the next two years.

4) Native Plant Community Establishment – Native plant communities of, marsh, sedge meadow, wet prairie and oak savanna would be reestablished over the remainder of the construction period. Planting lists are presented in Appendix J. Zones would be seeded and planted with seed and live plugs. Live plug areas will require predatory control, primarily stringing and caging to prevent Canada Goose and Deer predation. Before planting begins, invasive species would be removed and controlled to the greatest extent possible. Again, the duration of the construction contract would primarily be for spot herbicide application and additional planting; most activities similar to home gardening activities.

5) Control of eroded area – This work would be completed before native plants could be installed in the oak savanna of MU-2. Invasive shrubs and trees would be removed first, then an erosion control blanket would be installed that would ensure control of loose sediment and at the same time allow seeded native plants to germinate through blanket.

5) BMPs – Soil erosion and sediment control measures will be designed during design phase and will comply with local and federal environmental requirements. The minimum measures required at the project site include, mainly within PBP at sites that will be installed with water control valves:

- Hydroseeding, seeding, and mulching to stabilize disturbed areas
- Installation of silt fences around graded slopes and stockpile areas
- Stabilizing construction entrances to limit soil disturbance at the ingress/egress from the site
- Installing erosion blanket over unprotected finished grades that are to be unplanted for at least two weeks

6.3 – Real Estate

The Real Estate Plan, Appendix F, was prepared in support of the AFB-level feasibility study of the Lockport Prairie ecosystem restoration study. The Real Estate Plan identifies and describes the area proposed for construction, operation and maintenance of the Project, in addition to the real estate requirements and procedures for implementation of a recommended Plan.

Non-Federal Sponsor Lands – The State of Illinois Department of Natural Resources (IDNR) is the owner of the majority (623.69 acres) of the lands required for the project in the Prairie Bluff Preserve. At this time it is anticipated FPDWC will obtain fee title to the additional acreage through a transfer authorized by the Illinois State Legislature. House Bill 3241 will be amended to authorize the transfer from IDNR to FPDWC. Discussions with FPDWC have indicated the transfer would take place prior to award of a construction contract. The FPDWC currently owns in fee all areas within LPNP (303.18-acres) that will be utilized for this project. Total acreage of non-federal sponsor property needed for this project is 927.5-acres, which is inclusive of lands needed for ecosystem restoration, staging during construction, and operation and maintenance of restored habitats after construction is complete.

Non-Standard Estates – There are none for this study area.

LERRDs Crediting – Currently crediting amount is estimated to be \$ [REDACTED].

6.4 – Operation and Maintenance

The O&M costs of the project are estimated to an average annual cost of \$[REDACTED] with a 3.75% interest rate over 50 years. A detailed O&M Manual containing all the duties will be provided to the non-Federal sponsor after construction is closed out. The O&M for Chicago District ecosystem projects are practical and minimal due to initial project design efforts and design targets for sustainability. Mostly if not all of the O&M activities are no different than the specific activities that take place during construction. The O&M described here is not the same as the Adaptive Management measures described in the next section.

Invasive Plant Species Control – This maintenance activity is probably the most important to conduct. Preventing the establishment of invasive species and weedy vegetation prevents the need for large scale herbicide or physical eradication and replanting efforts. An annual maintenance plan should be drafted in conjunction with input from the Forest Preserve District of Will County taking into account the types of invasive and non-native species to be treated and the acreage of the treatment area. Problematic areas will include the bank transition and emergent marsh zones. Species such as white and yellow sweet clover, cut-leaved teasel, reed canary grass, common reed, buckthorn, honeysuckle, are known invasive species which will need to be kept at bay.

Precautions will be taken to ensure that any long term herbicide application is appropriately dispensed to remove non-native plants and invasive species while avoiding native plant communities.

Native Plant Community Maintenance – It will be required to maintain the species richness, abundance and structure of the restored plant communities within Lockport. Aside from minor re-plantings, it will be important to continue to protect plant communities from external disturbances, whether single incidents or chronic stressors. These can cause native plant communities to experience significant species richness declines even to the point of becoming monotypic stands. The best operational measure to quickly identify and rectify external stressors is vigilance. Routine inspections by the non-Federal sponsor's qualified stewards are imperative to notice adverse change quickly. The long term monitoring plan provided above will not catch quick change as would routine inspection by site stewards.

Precautions should be taken to ensure FPDWC staff understands the limits of native plant communities and how those areas should be maintained. Buffers around aquatic resources and native plants which border mowed turf grass areas should be avoided when routine mowing occurs.

Table 13. Detailed Costs of Average Annual O and M Activities

Ecosystem Management	Total AA Cost
Burning	[REDACTED]
Mowing	[REDACTED]
Invasive Control (herbaceous)	[REDACTED]
Invasive Control (Woody)	[REDACTED]
Seeding	[REDACTED]
TOTAL	[REDACTED]

6.5 – Monitoring Plan

Section 2039 of WRDA 2007 directs the Secretary to ensure that when conducting a feasibility study for a project (or a component of a project) for ecosystem restoration that the recommended project can include a plan, if considered necessary, for monitoring the success of the ecosystem restoration. Within a period of up to ten years from completion of construction of an ecosystem restoration project, monitoring shall be a cost-shared project cost.

(a) In General - In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.

(b) Monitoring Plan - The monitoring plan shall--

(1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and

(2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.

(c) Cost Share - For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-Federal responsibility.

Component 1 – Structural Sustainability

This component covers the structural sustainability of the implemented features. It is a qualitative assessment of whether each feature is retaining its physical character and project purpose. The most important information derived from this component would be to determine if adaptive management measures are needed or not. This monitoring would take place once every other year for 10-years. Structural components are currently broken down into the following:

- 1) Erosion control in Oak Savanna
- 2) Non-native shrub control in LPNP
- 3) Aggressive and invasive plant control in both LPNP and PBP
- 4) Hine’s Emerald Dragonfly rivulets
- 5) Plant community reestablishment
 - a) Marsh
 - b) Sedge Meadow
 - c) Oak Savanna
 - d) Prairie (Wet – Dry Mesic)
 - e) Floodplain Forest

The following is a list (living list) of parameters that would be assessed/measured:

1. Erosion control in Oak Savanna
 - a. Presence/absence of erosion
 - b. Cohesiveness and durability of vegetation
2. Non-native shrub control in LPNP
 - a. Presence/absence of non-native shrubs
 - b. Percent coverage
 - c. Map of locations of species

3. Invasive and aggressive herbaceous control in LPNP and PBP
 - a. Presence/absence of non-native shrubs
 - b. Percent coverage
 - c. Map of locations of species
4. Hine's Emerald Dragonfly
 - a. Monitor rivulet stage during critical times of season
 - b. Monitor larval stage of Hine's Emerald Dragonfly in rivulets

Hine's Emerald Dragonfly

The monitoring of this species would be most likely carried out by U.S. Fish and Wildlife Service, U. S. Geological Survey (USGS) and University of South Dakota (Dr. Soluk). These organizations have the expertise necessary to appropriately monitor this species in both adult and larval forms without negatively impacting the sensitive population at Lockport Prairie. U. S. Fish and Wildlife would coordinate both the USGS (stage monitoring in rivulets, map of rivulets section 2.2.5 Feasibility Report) and larval sampling (in rivulets) to ensure minimal impact to adult and larval populations at Lockport Prairie. Monitoring costs are assumed to be \$[REDACTED] for years when larval surveys are completed and \$[REDACTED] for when stage only data is collected. A detailed HED monitoring plan would be developed during design should this project move forward to design and implementation.

5. Plant Community Zones
 - a. Spatial coverage of each community type
 - b. Invasive species % coverage
 - c. Predator induced damages
 - d. Hydrologic induced damages
6. Human Interference & Damages
 - a. Physical damage
 - b. Removal
 - c. Rubbish and foreign debris

Visual observations during site visits will be used to determine if structural integrity and sustainability exist within the project. Based on said site visits, adaptive management protocols may be initiated.

Component 2 – Biological Response

These monitoring events would occur every other year during a 10-year monitoring period.

Plant Communities

Evaluation of plant community zones would be accomplished using the Floristic Quality Assessment Index (FQA) and native plant richness, as described in the 2.3.2 Plant Communities Assessment. In short, the FQA is a measure of overall environmental quality based the presence or absence of certain plant species. Plant species that are assigned a coefficient of conservatism of 5 to 10 are considered to be indicative of less human mediated disturbance and a higher level of functionality. As the area stabilizes after restoration measures are complete, the number of higher conservative plant species that become established should increase. Communities that have an average mean coefficient of conservatism of 3 to 5 are considered to be fair quality. This is a good estimate of the future quality of the area based on the current plant community restorations and ongoing monitoring.

Performance Standards will be set to measure the success of the restored plant communities. Standards are set after a baseline study of existing vegetation is completed. The following standards will be considered as part of the 10 year monitoring plan:

1. By the end of the third growing season, at least 75% of the vegetative coverage (as measured by aerial coverage) will consist of remnant native/seeded/planted species. The planted area shall exhibit at least the following at the end of each growing season: Year 1 – 25%, Year 2 – 50%, Year 3 – 75%
2. By the end of the tenth growing season, at least 95% of the planted areas must contain native, non-invasive perennial species as measured by aerial coverage. The planted area shall exhibit at least the following at the end of each growing season: Year 1 through 3 – 25%, Year 3 through 6 – 60%, Year 6 through 10 – 95%
3. None of the three most dominant species within the planted areas shall be invasive or non-native species, including but not limited to: Cattail (*Typha* spp.), Reed Canary Grass (*Phalaris arundinacea*), Purple Loosestrife (*Lythrum salicaria*), Common Reed (*Phragmites australis*), Canada Thistle (*Cirsium arvense*), Sandbar Willow (*Salix exigua*), Kentucky Blue Grass (*Poa pratensis*), and Sweet Clover (*Melilotus* spp.)
4. 100% of the planted trees and shrubs shall be alive, in healthy condition, and representative of the individual species at the end of each growing season.

Floristic Data Gathering Protocol

Formal line transect surveys will be conducted yearly. In general, surveys will be conducted in summer/early fall during the course of the monitoring period. Transects will be laid out to include all habitats and restoration measures. Vegetation community composition (identification of plant species and estimated coverage of each) within quadrats will be made along each transect in 10 meter intervals. The first and last 10 meters within each transect will be skipped. Within each quadrat, percent cover class values will be used and are broken down as follows: 1-5%, 6-25%, 26-50%, 51-75%, 76-95% and 96-100%. Because transect data may not provide information needed to evaluate overall herbicide efficacies (or plant establishment efforts), meander surveys will be conducted at the same time as line transect surveys to supplement transect data, with focuses on plant response to herbicide applications, prescribed burns, volunteer plant species occurrences, and survival, growth, and spread of planted species.

Avian Community

The monitoring for this community will be implemented; however, at this point in the study/project, it is unknown if the USACE, Forest Preserve District of Will County or Audubon Chicago Region would take on this role. The metric for avian communities will be a species count. The goal will be to document habitat specific species within each vegetation community. For instance, in a grassland community we would expect to see at least three grassland species utilizing the habitat. The use of the habitat via community specific species is a great indicator that the habitat is functioning appropriately. Failure to meet these criteria may result in the implementation of adaptive management processes.

Other Communities

Ancillary data will be collected on other assemblages as well. During monitoring, effort would be spent observing wildlife utilizing the habitats, including terrestrial insects, amphibians, reptiles, birds and mammals.

Component 3 – Planning Goal & Objectives

The goal of this proposed project is to restore native wetlands and create a more complex ecosystem to benefit fish, amphibians, reptiles, mammals, and migratory birds. Planning objectives for this study are as follows:

- Objective 1 – Reestablish Hydrogeomorphic processes to Support Natural Communities
- Objective 2– Eradicate Invasive Species for all Plant Communities
- Objective 3 – Restore and Propagate Diverse Native Plant Communities

These objectives would be assessed the same way as the FWOP and FWP project benefits were modeled as described in the preceding chapters. If the following specific targets are not achieved, the non-Federal sponsor would need to implement necessary measures to bring the quality of these plant communities up to the functional levels expected from restoration activities:

Table 14. Targets for Monitoring the Response of Plant Communities

Habitat Types	Acres	AA HSI*	AA HUs	Net AA HUs
MU1				
Marsh	80	0.51	40.48	29.84
Wet Prairie	115	0.49	56.47	41.17
Wet Mesic Prairie	270.3	0.43	117.04	81.09
Mesic Prairie	158.4	0.53	83.64	62.57
Total MU1 Acres	623.7			
MU2				
Oak Savanna	15.2	0.47	7.16	5.14
Marsh	4.5	0.46	2.08	1.41
Total MU2 Acres	19.7			
MU3				
Marsh	80	0.46	36.96	25.12
Sedge Meadow	5	0.49	2.45	0.65
Wet Prairie	10	0.37	3.71	1.01
Wet Mesic Prairie	15.6	0.41	6.32	1.12
Mesic Prairie	7	0.41	2.87	0.62
Dry Mesic Prairie	15	0.41	6.11	0.83
Floodplain Forest	10	0.39	3.87	2.33
Total MU3 Acres	142.6			
MU4				
Marsh	75	0.46	34.65	23.55
Sedge Meadow	4	0.49	1.96	0.52
Wet Prairie	20	0.37	7.42	2.02
Wet Mesic Prairie	13.8	0.41	5.59	0.99
Mesic Prairie	8	0.41	3.28	0.70
Dry Mesic Prairie	10	0.41	4.07	0.55
Floodplain Forest	10.7	0.39	4.14	2.49
Total MU4 Acres	141.5			

Monitoring Responsibilities

The US Army Corps of Engineers will currently be responsible for implementing all three Monitoring Components as described above. Coordination with partner agencies and organizations to discuss future monitoring responsibilities is planned.

Monitoring Costs & Funding Schedule

Year 1 of Monitoring starts the following growing season after construction is complete.

Table 15. Monitoring Costs per Year (Removed for Public Review)

Reporting Results

A yearly monitoring summary report would be drafted by the USACE that briefly summarizes the data collected and determines if adaptive management is needed. A final monitoring report would be drafted that details the outcomes of the restoration project.

6.6 – Implementation of Environmental Operating Principles

In assessing the environmental effects, USACE implemented the following Environmental Operating Principles (EOPs)² as part of this Feasibility Study.

Foster sustainability as a way of life throughout the organization.

Plans to restore native plant and fauna communities to Lockport Prairie will be easily sustainable because of the adaptability of the proposed communities to the conditions of Lockport Prairie. With minimal monitoring and maintenance to the newly introduced communities, outlined within the NER, should result in lasting success. Additionally, the proposed work is taking place within the FPDWC lands, which are cared for and maintained in perpetuity.

Proactively consider environmental consequences of all Corps activities and act accordingly.

The study team considered environmental consequences of proposed restoration features and construction activities. A cumulative effects assessment was completed to ensure all things were considered. Participation from Federal, state and local agencies and stakeholders were also held to ensure the most environmentally beneficial project. The study team does not anticipate negative impacts to the study area based on the restorative nature of the project, which would reestablish healthy native plant communities.

Create mutually supporting economic and environmentally sustainable solutions.

The study team formulated potential restoration plans to determine what the most cost-effective solution for ecosystem restoration is; however, appropriate engineering studies and biological assessments were performed to ensure that an implemented plan would be sustainable. Chicago District ecosystem designs avoided costly and unsustainable features such as pumps, weirs, and other fabricated structures. These types of features require continual monitoring, maintenance and funding to ensure they are providing required parameters for the ecosystem to be sustained. Designs for the Lockport Prairie restoration project rely on the parameters provided by the everyday system and predicted future changes.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments.

This project is exemplary for meeting USACE corporate responsibility and accountability. HTRW analyses were completed and reviewed to ensure construction activities would not result in an unlawful release of contamination (Appendix D). The NER plan is in compliance

² USACE. Environmental Operating Principles. <https://eko.usace.army.mil/usacecop/environmental/eop/>

with all applicable laws, executive orders and policy, which are discussed in the Federal Objective, Institutional Significance of the NER Plan and Compliance.

Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.

Risks associated with ecosystem restoration projects are typically low, for example, if certain portions of the project were to fail, other portions could be successful just as well; so it is not an all or nothing scenario. There is typically no chance for the loss of or causing discomfort to human life as well. In the case of Lockport Prairie, restoring native plant and fauna communities within the study area would only have beneficial affects to people and the environment. Risk considerations for this project primarily deal with the cost obligated to restore the environment and ultimately gain no benefits in return. The study team has not only incorporated very detailed engineering models to ensure the physical resilience of the habitat features, but have also weighed the biological conditions against other natural areas and similar restoration projects to ensure the plan will function as expected. The study has also presented this question to review teams within and outside of the USACE to ensure a high level of quality assurance. The USACE will be coordinating with the USFWS, USGS and University South Dakota on monitoring and managing Hine’s Emerald Dragonfly during construction.

Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.

This Feasibility Study was conducted in a manner that leveraged scientific knowledge from the USFWS, USGS, University of South Dakota, Openlands, ERDC and previously constructed Chicago District ecosystem restoration projects. The study team will also meet with governmental agencies, local industry, and environmental interest groups to gather scientific, economic and social information that pertains to the study area.

Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

This study process and subsequent Feasibility Report was drafted in a manner that has reduced redundancies, excessive and inconsequential information, and confusing engineering and policy discussions. Presentation of this study was done in a clear sequential order to show what the natural condition of Lockport Prairie was historically, what the existing conditions are now, what they would be if left alone, what could be done, and what should be done based on considerations of ecosystem improvement and associated costs.

6.7 – Division of Responsibilities

As established in PL99-662, as amended, project costs are shared with the non-Federal sponsor in accordance with project outputs. The Forest Preserve District of Will County has agreed to serve as the local cost-sharing sponsor for the Lockport Prairie 206 Aquatic Ecosystem Restoration project. The cost-sharing requirements and provisions will be formalized with the signing of the Project Partnership Agreement (PPA) between the FPDWC and USACE prior to initiation of contract award activities. In this agreement, the FPDWC will agree to pay 35 percent of the total project costs. Based on the cost sharing requirements, the total project cost and pertinent cost-sharing information for the restoration project are summarized in Tables 16 and 17 for the NER Plan.

Table 16. Estimated Total Cost (Removed for Public Review

Table 17. Cost Sharing Breakout in 1000's (Removed for Public Review)

Responsibilities

Federal - The estimated Federal cost share of the project is about \$ [REDACTED]. The USACE would complete the plans and specifications phase, which includes additional design studies and plans and specifications, contract for construction, overall supervision during construction, prepare an operation and maintenance manual, and participate in a portion of the post construction monitoring.

Non-Federal Responsibilities - Prior to initiation of the design phase, the Federal Government and the non-Federal sponsors will execute a PPA. The LERRDs and OMRR&R of the project will be the responsibility of the non-Federal sponsors for the proposed project. The estimated non-Federal share of the total first cost of the project is about \$ [REDACTED] and will be covered by LERRDs value of \$ [REDACTED] (credit of \$ [REDACTED]). The non-Federal Sponsor agrees to waive LERRD credit in excess of the 35% of project cost share. In addition to the total first cost, the feasibility level operations and maintenance costs of the project are estimated to total an annual cost of \$ [REDACTED]. The non-Federal sponsors shall, prior to implementation, agree to perform the following items of local cooperation:

1. Provide 35 percent of the separable project costs allocated to environmental restoration as further specified below
 - a) Provide the non-Federal share of all complete planning and design work upon execution of the PPA
 - b) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the government to be necessary for the construction and O&M of the project
 - c) Provide or pay to the government the cost of providing all features required for the construction of the project
 - d) Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration
2. Contribute all project costs in excess of the USACE implementation guidance limitation of \$10,000,000
3. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project or the functional portion of the project at no cost to the government in accordance with applicable federal and state laws and any specific directions prescribed by the government
4. Give the government a right to enter, at reasonable times and in a reasonable manner, upon land that the local sponsor owns or controls for access to the project for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project
5. Assume responsibility for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project or completed functional portions of the project, including mitigation features, without cost to the government in a manner compatible with the project's authorized purpose and in accordance with applicable federal and state laws and specific directions prescribed by the government in the OMRR&R manual and any subsequent amendments thereto
6. Comply with Section 221 of Public Law (P.L.) 91-611, Flood Control Act of 1970, as amended, and Section 103 of the WRDA of 1986, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resource project or separable element thereof until the nonfederal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element
7. Hold and save the United States free from damages due to construction of or subsequent maintenance of the project except those damages due to the fault or negligence of the United States or its contractors

8. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs
9. Perform or cause to be performed such investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 *U.S. Code* 9601 through 9675, that may exist in, on, or under lands, easements, or rights-of-way necessary for the construction, and O&M of the project, except that the nonfederal sponsor shall not perform investigations of lands, easements, or rights-of-way that the government determines to be subject to navigation servitude without prior written direction by the government
10. Assume complete financial responsibility for all necessary cleanup and response costs for CERCLA-regulated material located in, on, or under lands, easements, or rights-of-way that the government determines necessary for the construction and O&M of the project
11. To the maximum extent practicable, conduct OMRR&R of the project in a manner that will not cause liability to arise under CERCLA
12. Prevent future encroachment or modifications that might interfere with proper functioning of the project
13. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, P.L. 91-646, as amended in Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987, P.L. 100-17, and the uniform regulation contained in Part 24 of Title 49, *Code of Federal Regulations* (CFR), in acquiring lands, easements, and rights-of-way for construction and subsequent O&M of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said acts
14. Comply with all applicable federal and state laws and regulations, including Section 601 of Title VI of the Civil Rights Act of 1964, P.L. 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto and published in 32 CFR, Part 300, as well as Army Regulation 600-7 entitled "Non-Discrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"
15. Provide 35 percent of that portion of the total cultural resource preservation, mitigation, and data recovery costs attributable to environmental restoration that are in excess of 1 percent of the total amount authorized to be appropriated for environmental restoration
16. Do not use federal funds to meet the nonfederal sponsor's share of total project costs unless the federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute

Financial Capability of Sponsor

In accordance with regulation ER1105-2-100, Appendix D, where the non-Federal sponsor's capability is clear, as in the instances where the sponsor has sufficient funds currently available or has a large revenue base and a good bond rating, the statement of financial capability need only provide evidence of such. The non-Federal sponsor is committed to its specific cost share of the Design & Implementation (D&I) Phase, and expresses willingness to share in the costs of construction to the extent that can be funded.

CHAPTER 7 – RECOMMENDATION

I have considered all significant aspects of the problems and opportunities as they relate to the project resource problems of the Lockport Prairie and its associated habitats. Those aspects include environmental, social, and economic effects, as well as engineering feasibility.

I recommend Alternative 5.

Christopher T. Drew.
Colonel, U.S. Army
District Commander

References

- Cashatt, E.D. and T.E. Vogt. 1996. Population and habitat monitoring of Hine's emerald dragonfly (*Somatochlora hineana* Williamson) in northern Illinois in 1995. Unpublished report to the US Fish and Wildlife Service.
- Cashatt, E. and Vogt, T. 2001. Description of the larva of *Somatochlora hineana* with a key to the larvae of North American species of *Somatochlora* (Odonata: Corduliidae). *International Journal of Odonatology* 4(2): 93–105.
- Conservation Design Forum. 2003. Lockport Prairie Nature Preserve Vegetation Analysis. Prepared for The Forest Preserve District of Will County.
- Critical Trends Assessment Program (CTAP). 1998. Upper Des Plaines River Area Assessment, Volume 3: Living Resources. Illinois Department of Natural Resources, Champaign, IL.
- Critical Trends Assessment Program (CTAP). 2003. Lower Des Plaines River. An Inventory of the Region's Resources. Illinois Department of Natural Resources, Champaign, IL.
- Ervin, G., Herman, B., Bried, J. and C. Holly. 2006. Evaluating non-native species and wetland indicator status as components of wetlands floristic assessment. *Wetlands*. 26(4):1114-1129.
- Forest Preserve District of Will County. 2008. Personal Communication.
- Foster, S.E. and Soluk, D.A. 2004. Evaluating exuvia collection as a management tool for the federally endangered Hine's emerald dragonfly, *Somatochlora hineana* Williamson (Odonata: Cordulidae). *Biological Conservation* 118: 15-20.
- Garrison, Paul J and Pillsbury, R. 2008. A Paleoecological Study of Rusk County Lakes. Wisconsin Department of Natural Resources, Bureau of Integrated Science Services and University of Wisconsin-Oshkosh.
- General Land Office Field Survey Notes. 1821. Geological Survey Professional Paper, Volume 909. U.S. Geological Survey.
- Grabas, G. P., Bluckacz-Richards, E. A. and S. Pernanen. 2012. Development of a submerged aquatic vegetation community index of biotic integrity for use in Lake Ontario coastal wetlands. *Journal of Great Lakes Research*, 38:243-250.
- Graef, Anhalt Schloemer & Associates, Inc. 2004. Lockport Prairie Nature Preserve Ecological Assessment, Gap Analysis Summary and Fauna Analysis. Prepared for The Forest Preserve District of Will County.
- Graef, Anhalt, Schloemer and Associates. 2005. Land Use Analysis: Lockport Prairie Recharge Area. Submitted to Forest Preserve District of Will County, Joliet, IL
- Mierzwa, K.S., A.P. Smyth and E.D. Cashatt. 1995. Population dynamics of the Hine's emerald dragonfly (*Somatochlora hineana*) in Illinois. Pages 9-48 in K.S. Mierzwa, editor. The Hine's

- emerald dragonfly in Illinois: an assessment of population dynamics and habitat use. TAMS Consultants, Inc., Chicago, IL.
- NatureServe. 2014. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, VA. U.S.A. Available <http://explorer.natureserve.org>. (Accessed: November 2014).
- Panzer, R. and M. W. Schwartz. 1998. Effectiveness of a vegetation-based approach to insect conservation. *Conservation Biology*, 12:693-702.
- Panzer, R., Gnaedinger, K. and G. Derkovitz. 2010. The prevalence and status of conservative Prairie and sand Savanna insects in the Chicago Wilderness Region. *Natural Areas Journal*, 30:73-81.
- Pintor, L.M. & D.A. Soluk. 2006. Persistence of an endangered species facilitated by the presence of a predator. *Biological Conservation* 130: 584-591.
- Radomski, P. and D. Perleberg. 2012. Application of a versatile aquatic macrophyte integrity index of Minnesota lakes. *Ecological Indicators*, 20:252-268.
- Shuey, J. A., Metzler, E. H. and J. Tunesvick. 2012. Moth communities correspond with plant communities in Midwestern (Indiana, USA) sand prairies and oak barrens and their degradation endpoints. *The American Midland Naturalist*, 16:273-284.
- Soluk, D.A., B.J. Swisher, D.S. Zercher, J.D. Miller, and A.B. Hults. 1998. The ecology of Hine's emerald dragonfly (*Somatochlora hineana*): Monitoring populations and determining patterns of habitat use. Activity summary and report of findings (September 1996- August 1997). IL Nat. History Survey, Champaign, IL.
- Soluk, D.A., and K. Moss. 2002. The distribution and quality of Hine's Emerald Dragonfly habitat in relation to surface and groundwater dynamics in the Lockport Prairie Preserve. CorLands, Chicago, IL and USFWS, Barrington IL.
- Soluk, Hoekstra and Moss. 2004. Habitat Parameters of the Hine's Emerald Dragonfly: Using Temperature Loggers to Assess Hydrological Regime in Wetlands Supporting the Larval Stages. Prepared for USACE Chicago.
- Soluk, D.A. and C. Satyshur. 2005. Evaluation of the potential impacts of the I355 extension on the ecology, behavior and distribution of the endangered Hine's emerald dragonfly (*Somatochlora hineana*) in the Des Plaines River Valley. Preliminary report of Activities. Department of Biology, University of South Dakota. Report to Illinois State Toll Highway Authority.
- Soluk, D.A., Satyshur, C., Holmes, J. and E. Blas. 2006. The distribution and quality of Hine's Emerald Dragonfly in relation to surface and groundwater dynamics in the Lockport Prairie Nature Preserve. Final Report, submitted to the Corporation for Openlands, Chicago, IL
- Soluk, D. 2008. South Dakota State University. Personal Communication

- Swink, F and G. Wilhelm. 1979. Plants of the Chicago Region. 3rd edition. Indianapolis: Indiana Academy of Science.
- Swink, F. and G. Wilhelm. 1994. Plants of the Chicago Region. 4th edition. Indianapolis: Indiana Academy of Science.
- U.S. Fish & Wildlife Service, Department of the Interior. 2001. Hine's emerald dragonfly (*Somatochlora hineana* Williamson) recovery plan. U.S. Fish and Wildlife Service, Great Lakes-Big Rivers Region (Region 3), Fort Snelling, Minnesota.
- U. S. Fish and Wildlife Service. 2002. Birds of Conservation Concern, 2002. Division of Migratory Bird Management. Arlington, VA. 99p.
- U.S. Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Washington, D.C.
- Vogt, T.E. and E.D. Cashatt. 1994. Distribution, Habitat, and Field Biology of *Somatochlora hineana* (Odonata: Corduliidae). *Arthropod Biology*. 87(5):599-603.
- Wallner, A.M., Molano-Flores, B. and Dietrich, C.H. 2013. Using Auchenorrhyncha (Insecta: Hemiptera) to develop a new insect index in measuring North American tallgrass prairie quality. *Ecol. Indicators* 25: 58–64.
- White, John. 1978. Illinois Natural Areas Survey, Technical Report. Illinois Department of Conservation, Springfield, IL.
- Willman, H.B. 1971. Summary of the geology of the Chicago area. Illinois State Geological Survey Circular. No. 460:1-77.
- Williamson, E.B. 1931. A new North American *Somatochlora* (Odonata-Cordulinae). *Occ. Papers Mus. Zool. Univ. Michigan* 225: 1-8.
- Wilson, T. P. 1994. Ecology and the Spotted Turtle, *Clemmys guttata* at the western range limit. Master's Thesis. Eastern Illinois University.
- Zuehls, L.L. 2003. Ecological and behavioral significance of swarming behavior in dragonflies (Odonata). MS Thesis, University of Illinois at Champaign-Urbana, Urbana, Illinois. 91pp.